THE RELATIVE EFFECTIVENESS OF MANIPULATION WITH AND WITHOUT THE CONTRACT – RELAX – ANTAGONIST – CONTRACT TECHNIQUE OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION STRETCHING OF THE PIRIFORMIS MUSCLES IN THE TREATMENT OF SACRO - ILIAC SYNDROME

Dissertation submitted to the Faculty of Health Services in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic, at Technikon Natal.

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FEBRUARY 2001

I, Ivan Henry Ranwell, declare that this dissertation represents my own work.

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DEDICATION

I dedicate this research to my mom Sandy, whose strength, love and support has inspired me throughout my life.

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I would like to thank all my friends for the good times throughout the course of our studies.

Thank you to Tarryn, my supervisor, for all your time and guidance. Your efforts were greatly appreciated.

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ABSTRACT

This study aims to provide insight into the relative effectiveness of two different approaches in the treatment of sacro – iliac syndrome. Until recently, the sacro - iliac joints were not commonly considered to be mobile enough to suffer from detectable restriction of motion (Panzer and Gatterman 1995:453). Kirkaldy – Willis et al. (1992:126) however, states that sacro - iliac syndrome is a well defined and common type of dysfunction. Frymoyer et al. (1991:2114) also reports sacro - iliac syndrome to be common, although it is frequently overlooked as a source of low back pain.

This study will attempt to determine whether manipulation of the sacro – iliac joints together with Proprioceptive Neuromuscular Facilitation (P.N.F.) stretching of the piriformis muscles is a more effective treatment for sacro – iliac syndrome, than manipulation alone. This will be accomplished by determining which approach yields the best patient response in terms of subjective and objective clinical findings.

The study conducted was a randomised clinical trial consisting of two groups of 30 patients each. The patients were randomly allocated into the two groups. All patients received four treatments over a two - week period. Group one received manipulation of the sacro – iliac joints alone, while Group two received manipulation of the sacro – iliac joints together with P.N.F. stretching of the piriformis muscles. Only the sacro – iliac joint on the side of the sacro - iliac syndrome was manipulated, and only the piriformis

muscle on the side of the sacro – iliac syndrome was stretched. If any patients became asymptomatic within the treatment period, then the treatment was terminated. The patients were however required to return for all the remaining consultations for observational purposes. The results of the Numerical Pain Rating Scale, Oswestry Low Back Disability Index questionnaire, inclinometer and algometer readings, as well as the sacro - iliac orthopaedic tests, were recorded before the first and second treatments, and immediately following the fourth (final) treatment.

The data was analysed using the SPSS statistical package and was presented in the form of tables and bar graphs. Parametric testing was performed using the oneway ANOVA Tests and the two - tailed Unpaired T - Tests. The Bonferroni Tests were part of the oneway ANOVA Tests and referred to comparisons made between two treatments at a time only. Non - parametric testing was performed using the Mann - Whitney Tests, as well as the Wilcoxon Signed Rank Tests. The level of significance for all tests was set at 5% ($\alpha = 0.05$).

Analysis of the data indicated a significant statistical improvement in terms of the subjective and objective findings within each group. There was no significant statistical difference between Group one and Group two in terms of both subjective and objective findings, indicating that both groups responded favourably to the administered treatment.

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DEFINITION OF TERMS

Adjustment: The chiropractic adjustment is a specific form of direct articular manipulation using either long or short lever techniques with specific contacts and is characterized by a dynamic thrust of controlled velocity, amplitude and direction (Gatterman 1990:405).

Articulation: Place of union or junction between two or more bones of the skeleton (Gatterman 1990:405).

Biomechanics: The application of mechanical laws to living structures. The study and knowledge of biological function obtained from an application of mechanical principles (Gatterman 1990:406).

Chiropractic: Chiropractic is a discipline of the scientific healing arts concerned with the pathogenesis, diagnostic, therapeutics and prophylaxis of functional disturbances, patho - mechanical states, pain syndromes, and neurophysiological effects related to the statics and dynamics of the locomotor system, especially of the spine and pelvis (Gatterman 1990:406).

Contra - indication: Any condition, especially any condition of disease, that renders one particular line of treatment improper or undesirable (Gatterman 1990:407).

Counter - nutation: Motion of the sacrum about a coronal axis, in which the sacral base moves anteriorly and inferiorly and the tip of the coccyx moves posteriorly and superiorly (Gatterman 1990:412).

Fixation: The immobilisation of a vertebra in a position of movement when the spine is at rest, or in a position of rest when the spine is in movement (Gatterman 1990:408).

Flexibility: The ability of a structure to deform under the application of a load (Gatterman 1990:408).

Manipulation: A passive manoeuvre in which specifically directed manual forces are applied to vertebral and extra - vertebral articulations of the body, with the object of restoring mobility to restricted areas (Gatterman 1990:410).

Motion palpation: Palpatory diagnosis of passive and active segmental joint ranges of motion (Gatterman 1990:412).

Nutation: Motion of the sacrum about a coronal axis, in which the sacral base moves anteriorly and inferiorly and the tip of the coccyx moves posteriorly and superiorly (Gatterman 1990:412).

Palpation: The application of variable manual pressure through the surface of the body for the purpose of determining the shape, size, consistency, position, inherent mobility, and health of the tissues beneath (Gatterman 1990:412).

Pelvic extension: Position of the pelvis in which the vertical plane through the anterior superior iliac spines is anterior to a vertical plane through the symphysis pubis. Pelvic extension is a rotary movement of the pelvic ring around the X or coronal axis, with the axis passing through the femoral heads (Gatterman 1990:412).

Pelvic flexion: Position of the pelvis in which the vertical plane through the anterior superior iliac spines is posterior to a vertical plane through the symphysis pubis. Pelvic extension is a rotary movement of the pelvic ring around the X or coronal axis, with the axis passing through the femoral heads (Gatterman 1990:412).

Sacro - iliac fixation: The absence of normal motion at the sacro - iliac joint demonstrable by motion palpation in which the axis of rotation has shifted to either the superior or inferior portion of the sacro - iliac joint, or rarely a situation in which there is total joint locking with no axis of rotation (Gatterman 1990:412).

Sacro – iliac syndrome: Pain over one sacro – iliac joint in the region of the posterior superior iliac spine, which may be accompanied by referred pain over the buttock, greater trochanter, groin, posterior thigh, knee, and occasionally to the postero – lateral calf, ankle and foot (Kirkaldy - Willis 1992:123).

Subluxation: Aberrant relationship between two adjacent articular structures, which may have functional or pathological sequelae, causing an alteration in the biomechanical and/or neurophysiological reflexes, their proximal structures, and/or body systems that may be directly or indirectly affected by them (Gatterman 1990:415).

Translation: Motion of a rigid body in which a straight line in the body always remains parallel to itself (Gatterman 1990:415).

OBJECTIVES

Objective One

The first objective was to determine the relative effectiveness of sacro - iliac joint manipulation versus sacro - iliac joint manipulation in conjunction with the Contract - Relax - Antagonist - Contract technique of Proprioceptive Neuromuscular Facilitation stretching of the piriformis muscles, in terms of subjective clinical findings.

Objective Two

The second objective was to determine the relative effectiveness of sacro - iliac joint manipulation versus sacro - iliac joint manipulation in conjunction with the Contract - Relax - Antagonist - Contract technique of Proprioceptive Neuromuscular Facilitation stretching of the piriformis muscles, in terms of objective clinical findings.

Objective Three

The third objective was to integrate the subjective and the objective data from the two sacro - iliac joint treatment protocols, in order to determine which is the more reliable and effective method of treatment of sacro - iliac joint syndrome.

CHAPTER ONE

1. INTRODUCTION

According to Ross (1997), low back pain is one of the most common clinical disorders seen by health care practitioners today. Hendler et al. (1995) describes low back pain as the most common, costly and disabling musculoskeletal condition. Burton and Cassidy (1992:3) state that the lifetime prevalence of low back pain is from 60% to 90%.

Shaw (1992) reports that mechanical dysfunction of the sacro - iliac joint is a very common cause of low back pain, while Bernard and Cassidy (1991:2114) state that sacro - iliac syndrome is a common, although frequently overlooked source of low back pain. A study by Bernard and Kirkaldy – Willis (1987) showed that the sacro – iliac joint was the primary source of low back pain in 22.5% of 1293 patients presenting with back pain.

Chiropractic manipulation (adjustment) delivers a high velocity, low amplitude thrust which restores articular mobility (Gatterman 1990:49). Kirkaldy - Willis and Burton (1992:249) state that manipulation is the most certain way of relieving the symptoms of sacro - iliac syndrome. The same authors go on to say that this is achieved by reducing hypertonicity in the posterior muscles that maintain the joint in a state of fixation, as well as restoring the joint movement. Cassidy and Mierau (1992:221) report that there are many different techniques available to manipulate the sacro – iliac joint, but they have found the side posture method to be the most effective.

Flexibility of the pelvis and the lower extremities plays an important role in segmental spine function and is necessary for proper body mechanics (Mayer et al. 1991:242). According to Donelsan (1991), stretching exercises have been shown to improve musculo - ligamentous elasticity and spinal mobility, which prepares the spinal segments for the intended movement.

Retzlaff et al. (1974) recommends several stretching techniques including reciprocal inhibition, which for the piriformis muscles, is done by contracting the antagonistic medial rotator muscles without allowing any medial rotation movement of the thigh. After relaxation, the slack in the piriformis muscles is then passively taken up by increasing medial rotation. According to Moreau and Nook (1995), reciprocal inhibition is the first neurophysiologic principle of the Contract - Relax - Antagonist - Contract (C.R.A.C.) technique of Proprioceptive Neuromuscular Facilitation (P.N.F.) muscle stretching.

Moore and Hutton (1980) used electromyography to investigate the difference between static stretching and two P.N.F. techniques, and concluded that P.N.F. (C.R.A.C.) stretches were more effective than static stretches for improving flexibility. Mcatee (1993:11) reviewed fourteen studies and found that in eight of those studies, P.N.F. stretching was significantly more effective for increasing range of motion and flexibility than static, ballistic or passive stretching.

1.1. Benefits of the study

Sacro - iliac syndrome is a common neuromusculoskeletal disorder, for which this study serves to establish further knowledge and insight, in terms of a more effective management approach. If low back pain research can show that the piriformis muscles are functionally related to the sacro – iliac joints (to the extent that by increasing their flexibility, the chiropractor can reduce the symptoms of sacro – iliac syndrome), this would enable a more effective treatment of the sacro – iliac syndrome than manipulation alone.

Furthermore, if the addition of P.N.F stretching of the piriformis muscles not only reduces the symptoms of sacro – iliac syndrome, but improves the patient's quality of life in a shorter time – span, it will be of even further benefit to both chiropractor and patient.

CHAPTER TWO

2. REVIEW OF THE RELATED LITERATURE

2.1. Anatomy of the sacro – iliac joint

The sacro – iliac joint is a true synovial (diarthrodial) joint in that it has a joint cavity containing synovial fluid, and adjacent bones with ligamentous connections. It also has an outer fibrous joint capsule with an inner synovial lining, and cartilaginous surfaces allowing motion (Bernard and Cassidy 1991:2109).

Kampen and Tillman (1998) report observed structural differences between sacral and iliac cartilage, already beginning in infancy. The sacral articular surface is covered with hyaline cartilage and reaches 4mm in thickness by adulthood, while the iliac articular surface is composed of a dense fibrillar network of collagen which by adulthood becomes hyaline, reaching a thickness of 1 to 2mm.

Bernard (1997:75) describes the iliac cartilage as rough in texture and bluish in colour prior to puberty, while the sacral cartilage is smooth, glistening and creamy - white. As a person ages, so the size, shape and roughness of the articular surfaces varies greatly, being smooth in childhood and becoming irregular with depressions and elevations during adulthood (Magee 1992). These morphological changes exhibited by both articular facets are more pronounced in the iliac cartilage and resemble osteoarthritic degeneration, although large areas of the iliac cartilage still remain hyaline in nature (Kampen and Tillman 1998).

According to Gatterman (1990:112), the contours of the sacro – iliac joints continue to change with age, and after the third decade the articular cartilage becomes roughened and frayed. Vleeming et al. (1990a) points out that this roughening of the articular surfaces of the sacro – iliac joints is a physiological, or non - pathologic adaptation to the forces exerted at the sacro – iliac joints.

Pelvic structural differences are evident within the gender distribution. Vleeming et al. (1990a) states that the articular surfaces of the female sacro - iliac joints are both smaller and flatter than that of the male. Gray (1994:311) points out that the female ilia are less sloped and the anterior iliac spines are more widely separated, hence the greater prominence of the hips. Also, the female sacrum is shorter and wider than that of the male with a ventral concavity that is deeper (Alderink 1991).

According to Cassidy and Mierau (1992:217), the hormone relaxin causes weakening of ligaments and the pubic symphysis during pregnancy and menstruation, and this may lead to a relative hypermobility of the female sacro - iliac joints. Walker (1992) reports that there is clinical and radiographic evidence to support the presence of increased sacro – iliac joint mobility in the end phase of pregnancy.

Moore (1992:251) describes the sacrum as being suspended between the iliac bones. He states that these bones are firmly held together by the interosseous and posterior sacro – iliac ligaments, which are the strongest ligaments in the body.

Moore (1992:251) goes on to describe the sacro - iliac ligaments as follows: The interosseous ligaments unite the iliac and sacral tuberosities, and their fibres blend with, and are supported by the posterior sacro – iliac ligaments. The posterior sacro – iliac ligaments are composed of strong, short transverse fibres joining the ilium and first and second lateral sacral tubercles, and long vertical fibres uniting the third and fourth transverse sacral tubercles to the posterior iliac spines. The anterior sacro – iliac ligaments are composed of a thin, wide sheet of transverse fibres covering the abdomino – pelvic surface of the sacro – iliac articulation.

The iliolumbar, sacrotuberous and sacrospinous ligaments make up the accessory ligaments of the sacro – iliac joint, as described by Moore (1992:251): The triangular - shaped iliolumbar ligament connects the tip of the transverse process to the iliac crest posteriorly, while its inferior fibres attach to the lateral sacrum. The sacrotuberous ligament passes from the sacrum to the ischial tuberosity, with wide attachments to the dorsal surfaces of the sacrum, coccyx and posterior inferior iliac spine. The sacrospinous ligament extends from the lateral margin of the sacrum and coccyx to the ischial spine, and is also related anteriorly to the coccygeus muscle.

The sacro – iliac joint has extensive sensory innervation. According to Bernard and Cassidy (1991:2112) the lateral branches of the posterior primary rami from L4 to S3 supply the posterior ligaments and joint capsule. The anterior innervation is from L2 to S2. In addition, both anterior and posterior primary rami are involved (Daum 1995). This wide range of segmental innervation accounts for the variable referred pain patterns seen in sacro - iliac syndrome (Bernard and Cassidy 1991:2112).

2.2. Biomechanics of the sacro – iliac joint

Cassidy and Mierau (1992:215) state that the sacro - iliac joints have a small range of motion, which decreases with age, although the biomechanical function of the joints is largely unknown. According to Panzer and Gatterman (1995:453), there exists between three to five degrees of motion in the sacro – iliac joints (demonstrated in both cadaver specimens and living subjects), and until recently, the sacro - iliac joints were not considered mobile enough to cause significant dysfunction as a result of restricted motion.

Colachis et al. (1963) reports that the sacro – iliac joint does not rotate on a fixed axis, but on a dynamic angular axis. Bernard and Cassidy (1991:2113) share this view, adding that the predominant motion seems to be x - axis rotation (flexion and extension), with a degree of z - axis translation (anterior and posterior movement). The same authors stress that the exact model of sacro - iliac joint movement is unknown due to the complexity of the joint motion.

Flexion or nutation of the sacro – iliac joints occurs on trunk flexion, and involves movement of the anterior tip of the sacral promontory anteriorly and inferiorly, while the coccyx moves posterioly and superiorly in relation to the ilium (Norkin and Levangie 1992:156). The same authors add that during nutation, the antero - posterior diameter of the pelvic outlet is increased and the antero - posterior diameter of the pelvic brim is decreased. The opposite motion to nutation is referred to as counter - nutation or extention, during which the reverse motion occurs.

The articular surfaces of the sacro – iliac joints become irregular with depressions and elevations beginning to develop at puberty (Gatterman 1990:112). This roughening adds to the strength of the joint, but may also restrict joint motion (Hendler et al. 1995). Bernard and Cassidy (1991:2113) state that movement in the sacro – iliac joint decreases in men between 40 and 50 years of age and in females after 50 years of age. According to Bowen and Cassidy (1981), degeneration leads to fibrous or fibrocartilagenous adhesions and occasionally ankylosis in the elderly. Walker (1992) states that ankylosis tends to be more partial than complete, being peripheral or central, and bony, fibrous or chondroid.

2.3. The piriformis muscle

The piriformis is a thick and bulky muscle in most individuals (Travell and Simons 1992:188). According to Moore (1992:252), this pear – shaped muscle occupies a key position in the gluteal region, lining the posterior pelvic wall laterally. The piriformis muscle attaches proximally to the pelvic surface of the second to the fourth sacral segments, as well as to the superior margin of the greater sciatic notch and sacrotuberous ligament. It leaves the pelvis through the greater sciatic foramen to reach its distal attachment at the greater trochanter of the femur (Moore 1992:255). The piriformis muscle occupies the greater sciatic foramen and of the small muscles of the gluteal area, lies uppermost (Retzlaff et al. 1974).

Anatomical variations of the piriformis muscle include additional medial attachments to the first and fifth sacral vertebrae and coccyx, as well as possible fusion with the gluteus medius or minimus muscles above, or with the superior gemellus muscle below (Travell and Simons 1992:188).

The function of the piriformis muscle is primarily lateral rotation of the thigh in the non – weight – bearing limb while it also acts in abduction when the hip is flexed at 90 degrees (Travell and Simons 1992:186). Moore (1992:255) states that the piriformis muscle also assists in holding the head of the femur in the acetabulum.

Innervation of the piriformis muscle is by the anterior primary rami of the first and second sacral nerves (Retzlaff et al. 1974).

Although the sacro – iliac joints are not crossed by any muscles, certain authors share the view which suggests that muscles, the piriformis in particular, influence sacro – iliac joint stability, motion and possibly pathology (Walker 1992, Porterfield and DeRosa 1992, Mitchell et al. 1979, Gatterman 1995:455). Walker (1992) states that all adjacent muscles to the sacro – iliac joint (including the piriformis) have fibrous expansions that blend with the anterior and posterior sacro – iliac joint ligaments and contribute to the strength of the joint capsule and ligaments, and thus the joint's stability. Walker (1992) goes on to say that these tissues deriving from muscle expansions, may be placed in tension when the muscle bellies contract, and muscle activity therefore is likely to increase any symptoms arising from sacro – iliac joint pathology.

Porterfield and DeRosa (1990) state that the piriformis muscle, due to its direct sacral attachment, must be considered relevant to sacro – iliac function and dysfunction. Mitchell et al. (1979) claims that the diagonal or oblique axes within the sacro – iliac joints are created by contraction of one of the piriformis muscles. For instance, when the left piriformis muscle contracts, it pulls the sacrum obliquely downward against the left lower pole of the sacro – iliac joint, creating a pivot point and resulting in a right rotary motion with an inferior linear displacement along the right sacro – iliac joint. This sacral motion about the right and left diagonal axes occurs reciprocally during gait. Panzer and Gatterman (1995:455) state that abnormal piriformis muscle contraction is often associated with sacro - iliac syndrome, and may result in a hypermobile sacro - iliac joint, which in turn may cause pain in the ipsilateral hip.

Some authors are however opposed to the idea that muscles have a direct influence on the sacro – iliac joint. Bernard and Cassidy (1991:2113), and Cassidy and Mierau (1992:215) maintain that although the sacro – iliac joint is surrounded by some of the largest and most powerful muscles in the body, none of them are known to have any direct influence on the motion of the joint. According to Miller (1985), contraction of any of the adjacent muscles such as the erector spinae, psoas, quadratus lumborum, piriformis, abdominal obliques, and glutei muscles, will place shear and moment loads on the sacro - iliac joints in proportion to their contraction forces.

2.4. The sacro – iliac syndrome

In the search for causes of low back pain, the sacro – iliac joint has gained renewed interest as a pain generator (Indahl et al. 1999). More specifically, Giles and Singer (1997:178) report that the importance of sacro – iliac syndrome as a cause of lower back pain has gained increasing recognition in the last few years.

The sacro – iliac joints are a major link between the trunk and lower limbs and are subject to heavy loads, both static and dynamic (Rickenbacher et al. 1985). Shaw (1992) points out that resultant mechanical dysfunction of the sacro - iliac joint is a very common cause of low back pain. McGill (1987) adds that there is little doubt that the large mechanical forces placed on the sacro - iliac joint during everyday activities make this area a site for clinical pain.

Kirkaldy – Willis et al. (1992:126) states that sacro - iliac syndrome is a well defined and common type of dysfunction. Bernard and Cassidy (1991: 2114) also report that sacro - iliac syndrome is common, although it is frequently overlooked as a source of low back pain. Aprill (1992) states that sacro - iliac syndrome appears to be an overlooked condition, which is often not considered by many clinicians to be involved in the diagnosis and treatment of mechanical back pain. A retrospective review by Bernard and Kirkaldy - Willis (1987) showed that the sacro - iliac joint was the primary source of low back pain in 22.5% of 1293 patients presenting with back pain.

Cassidy and Mierau (1992:218) state that the diagnosis of sacro - iliac syndrome is based almost entirely on a history of mechanical backache and clinical examination. According to DonTigny (1997), recognition and diagnosis of sacro – iliac joint dysfunction can be made by identifying a few of the most common resultant manifestations. These are the change in apparent leg length, pain deep in the posterior inferior iliac spine (P.I.I.S.), and pain at the posterior superior iliac spine (P.S.I.S.) at the attachment of the superficial long posterior sacro – iliac ligament.

Rickenbacher et al. (1985) reports that clinical examination of the sacro - iliac joint should include inspection and assessment of leg length inequalities and pelvic torsion, as well as palpation of the iliacus, adductor, gluteus major and piriformis muscles. Aprill (1992) also refers to the importance of pelvic obliquity and leg length inequality in the evaluation of sacro - iliac syndrome.

Kirkaldy - Willis et al. (1992:124) describes sacro - iliac syndrome in terms of a collection of symptoms and signs. Symptoms include pain over the back of the sacro – iliac joint (varying in degree of severity), referred pain in the groin, greater trochanter, down the back of the thigh to the knee, and occasionally down the lateral or posterior calf to the ankle, foot and toes. Signs include tenderness or pressure over the P.S.I.S. in the region of the sacro – iliac joint, or in the buttock. The sacro - iliac joint movement is also usually restricted.

Daum (1995) states that patients will most frequently have pain or tenderness directly over the posterior sacro – iliac joint. According to Bernard and Cassidy (1991:2115) the pain is usually unilateral with a right-sided predominance and may be sharp, aching or dull. Bernard and Cassidy (1991:2115) also state that the pain is aggravated by bending, sitting or riding in a motor vehicle, and is alleviated by standing and walking.

There is a general consensus amongst physicians with regards to sacro – iliac joint pain referral patterns. In a retrospective study by Slipman et al. (2000) it was found that in fifty patients observed, 94% described buttock pain, 72% described lower lumbar pain, 50% described lower extremity pain, and 28% described leg pain distal to the knee. According to Gatterman (1995:454), pain from the sacro – iliac joint is referred over the ipsilateral buttock and may extend down the lateral and posterior calf, and occasionally to the ankle, foot and toes. Posteriorly, pain may be referred into the L5, S1 and S2 dermatomes. Pain that is referred from the anterior aspect of the joint may radiate to the L2 and L3 dermatomal areas.

Neurological findings such as motor, reflex, or sensory deficits, as well as nerve root tension signs are absent with regards to the physical findings common to sacro - iliac syndrome (Bernard and Cassidy 1991:2115).

2.5. Tests for sacro – iliac joint dysfunction

Kirkaldy-Willis et al. (1992:124) states that two out of three orthopaedic pain provocation tests (Gaenslen's test, Patrick Faber's test, and Yeomann's test) need to be positive in order to make the diagnosis of sacro - iliac syndrome. Bernard and Cassidy (1991:2117) state that Gaenslen's, Patrick Faber's, and Yeomann's tests all have a high degree of interexaminer reliability, while Cassidy and Mierau (1992:219) report that these sacro - iliac tests remain the most useful for diagnosing sacro - iliac syndrome. Cassidy and Mierau (1992:219) do however add that pain provocation tests place equal stress on the hip joint, and hip joint pathology should therefore be ruled out before their interpretations.

Gaenslen's test:

Giles and Singer (1997:397) describe Gaenslen's test with the patient lying supine on a table. Both legs are drawn onto the chest and then the unsupported leg is allowed to drop over the edge, while the opposite leg remains flexed. Complaints of subsequent pain in the sacro – iliac joint area gives an indication of pathology in that area.

Hendler et al. (1995) reports that Gaenslen's test is frequently positive on examination of a patient with sacro - iliac joint dysfunction. Laslett and Williams (1994) evaluated Gaenslen's test (as well as the Thigh Thrust or Posterior Shear test) for inter-examiner reliability. The results of the study showed an 88.2% reliability of Gaenslen's test and a 94.1% reliability of the Thigh Thrust test, between therapists.

Patrick Faber's test:

Giles and Singer (1997:397) describe Patrick Faber's test with the patient lying supine on a table. The foot of the painful side is placed on the opposite knee. The hip is therefore flexed, abducted, and externally rotated, which according to Panzer and Gatterman (1995:456), explains the acronym FABER. Panzer and Gatterman (1995:456) state that pain can be localised to either the ipsilateral hip or sacro – iliac joint.

In a double – blinded clinical trial by Broadhurst and Bond (1998), the sensitivity and specificity of three commonly used pain provocation tests for sacro - iliac joint dysfunction was assessed. The tests were Patrick Faber test, posterior shear (POSH) test and the resisted abduction (REAB) test. The results of the trial showed 77% sensitivity and 100% specificity for the Patrick Faber test, 80% sensitivity and 100% specificity for the POSH test, and 87% sensitivity with 100% specificity for the REAB test.

Yeomann's test:

Panzer and Gatterman (1995:460) describe Yeomann's test (thigh hyperextension). The test is performed with the patient lying prone. The ipsilateral thigh is hyperextended and resultant pain localised to the sacro – iliac joint indicates a test positive for sacro – iliac joint involvement. Extension of the involved thigh is often noticeably restricted.

According to Panzer and Gatterman (1995:456), the manipulable sacro – iliac subluxation is best detected through motion palpation. Dreyfuss et al. (1994) reports that the standing and seated flexion tests, as well as the Gillet motion palpation screening test (which is thought to be the most sensitive), play an important role in the diagnosis of sacro – iliac joint pathology. Hertzog et al. (1989) investigated the reliability of the Gillet motion palpation test, and a 60% inter – examiner agreement was reported from 11 patients diagnosed with sacro – iliac joint dysfunction.

The Gillet test is described by Schafer and Faye (1989:260). In order to screen iliac flexion and extension on the sacrum in the standing position, the examiner's thumbs are placed on the patient's P.S.I.S.'s. The patient is then asked to raise the right knee up and down, bending the knee as if taking a high step. The right P.S.I.S. is felt to arc posteriorly and inferiorly. After about 20 degrees of leg raise, the patient's left P.S.I.S. drops backward and downward. This is normal sacro – iliac motion. Any motion other than this indicates a problem in the joint. The test is repeated by having the patient raise the left knee up and down. If the joint is fixated, the pelvis tends to remain level, or possibly raise rather than drop.

In order to evaluate standing superior joint motion, one thumb is placed on the patient's sacral base and the other thumb on the P.S.I.S. of the side being tested. The patient is asked to raise the flexed knee of the side being tested, as if taking a high step, and the separation of the thumbs is noted. The sacral base normally arcs anteriorly and inferiorly, or conversely, the P.S.I.S. moves backward and downward. The test is repeated with the patient raising the opposite knee. If the superior sacro – iliac joint is locked, the sacrum and ilium move as a unit and the thumbs will not separate appreciably, while the sacral tissues remain taut.

In order to evaluate standing inferior joint motion, one thumb is placed on the patient's sacral apex and the other thumb on the ischial protuberence. The patient is asked to raise the flexed knee of the side being tested, as if taking a high step, and the separation of the thumbs is noted. The ischium should move antero – superiorly and slightly lateral on the sacrum. If the inferior joint is locked, the ischium and sacral apex move as a unit.

Dreyfuss et al. (1994) conducted a prospective clinical trial in order to assess the incidence of false - positive screening in tests used to detect sacro – iliac joint pathology. In conclusion, it was found that overall, 20% of asymptomatic individuals had positive findings in one or more of the seated and standing flexion tests and the Gillet test. Therefore according to the study, asymmetrical motion due to relative hypomobility occurs in asymptomatic joints. According to Sturesson et al. (1989), identical movements of symptomatic and asymptomatic sacro - iliac joints under physiologic loads demonstrates that analysis of the mobility of sacro - iliac joints cannot identify sacro - iliac joint dysfunction in patients with sacro - iliac syndrome.

Haas and Panzer (1995:59) are of the opinion that the validity of adjustive indicators remains elusive due to the absence of a 'gold standard' for identifying manipulable subluxations. Haas and Panzer (1995:59) go on to say that although there is strong consistency of test measures, this does not ensure validity, and reliability assessment therefore remains extremely important.

Bernard and Cassidy (1991:2117) state that radiographic evaluation rarely adds any useful information in the diagnosis of sacro – iliac syndrome, although it is most useful in ruling out infection, inflammation, metabolic, or traumatic conditions. The same authors point out that there is some debate over the value of quantitative bone scanning of the sacro – iliac joints. Cassidy and Mierau (1992:217) however report that when two or more sacro – iliac stress tests are positive, bone scans show increased radionuclide uptake over that joint, which suggests that sacro – iliac syndrome is associated with a chronic low grade inflammation.

2.6. Manipulation of the sacro – iliac joints

Chiropractic manipulation (adjustment) delivers a high velocity, low amplitude thrust which restores articular mobility (Gatterman 1990:49). Twomey and Taylor (1995) define manipulation as a high velocity, low amplitude passive thrust to a joint, which is a common treatment used to increase range of motion and decrease pain associated with low back joint dysfunction.

Gatterman (1990:40) explains that the rationale for the application of chiropractic manipulation extends beyond the simple restoration of joint mobility. It involves the reduction of the subluxation complex, which leads to pathophysiology and subsequently, pathology within the joint. Gatterman (1990:415) defines the subluxation as an aberrant relationship between two adjacent articular structures, which may have functional or pathological sequelae. This results in an alteration in the biomechanical and/or neurophysiological reflexes of these articular structures, their proximal structures, and/or body systems that may be directly or indirectly affected by them.

Anderson et al. (1992) conducted a meta - analysis of 23 randomised controlled clinical trials of spinal manipulation and reported that manipulation is more effective than any array of other comparison interventions in the treatment of low back pain.

Hendler et al. (1995) reports that symptoms arising from sacro - iliac subluxations are dramatically reduced with manipulation. Bernard and Cassidy (1991:2126), however, report that the existence of sacro – iliac joint subluxations has never been proven, although this theory is supported with claims of success from the reduction of these displacements by manipulation directed at the sacro – iliac joints.

Specific manipulative therapy (S..M.T.) directed at the sacro – iliac articulation is the treatment of choice for sacro – iliac syndrome (Cassidy and Mierau 1992:221). In fact, Kirkaldy - Willis and Burton (1992:249) state that manipulation is the most certain way of relieving the pain of sacro - iliac syndrome. Prospective clinical studies have shown a successful response in more than 90% of patients receiving daily manipulation over a two to three week period for chronic disabling sacro – iliac syndrome (Cassidy and Mierau 1992:221). The same authors do however go on to say that successful treatment with manipulation alone does not prevent recurrence of sacro – iliac syndrome.

Cassidy et al. (1992:292) report that the results of 25 controlled clinical trials have shown that manipulation is successful in increasing the recovery rate from low back pain, although claims of long term effects have been unsupported. Meade et al. (1990) conducted a randomised controlled trial comparing chiropractic manipulation to hospital outpatient treatment, and found significantly greater improvement in the manipulation group after a two - year follow up, compared to the outpatient group.

Cassidy and Mierau (1992:221) point out that there are many different techniques available to manipulate the sacro – iliac joint, but have found the side posture method to be the most effective, by inducing mobilisation of a stiff or fixated joint. Bergmann et al. (1993:498) states that side posture sacro - iliac adjustments are the most common manipulative methods for treating sacro - iliac joint dysfunction.

Panzer and Gatterman (1995:465) describe the side posture technique with the patient lying on the unaffected side. The doctor's stabilising hand tractions the patient's shoulder while the thrusting hand contacts the affected ilium. The manipulative thrust is directed through the ilium, down the thigh and the long axis of the patient's flexed leg. The patient's superior leg is tractioned with the doctor's inferior thigh, and a body drop is simultaneously instituted as a thrust is delivered.

Bergmann et al. (1993:497) states that motion of the sacro – iliac joint occurs largely in flexion and extension (sagittal plane), and it is therefore not surprising that this is generally the plane of blocked sacro – iliac joint motion. Flexion dysfunction is corrected by contacting the ilium and inducing posterior - inferior movement of the ilial articular surface relative to the ipsilateral sacral cartilage, while extension dysfunction is corrected by contacting the ilium and inducing anterior - superior movement of the ilial surface relative to the ipsilateral sacral articular surface. A contact can be taken on the sacrum, inducing posterior superior movement of the sacral articular surface relative to the ilial articular surface.

2.6. Proprioceptive Neuromuscular Facilitation

According to Mayer et al. (1991:242), flexibility of the pelvis and the lower extremities plays an important role in segmental spine function and is necessary for proper body mechanics. Donelsan (1991) reports that stretching exercises have been shown to improve musculo - ligamentous elasticity and spinal mobility, which prepares the spinal segments for the intended movement.

According to Liebenson (1989), there are two types of muscle relaxation techniques. These are passive muscular relaxation techniques (P.M.R.T's.) which include massage, trigger point therapy, joint mobilisation, and chiropractic adjustive techniques, and active muscular relaxation techniques (A.M.R.T's.) which include the P.N.F. techniques of physical therapy and the muscle energy procedures (M.E.P.) of the osteopathic field. He believes the A.M.R.T's. to be advantageous as they limit patient dependency by requiring active co - operation of the patient.

Liebenson (1989) divides A.M.R.T's into two parts. The first part is inhibition of a short or tense muscle by a resisted contraction of it or its antagonist, while the second part involves lengthening of the muscle during the resultant inhibitory period, which immediately follows the contraction phase.

Retzlaff et al. (1974) recommends several stretching techniques including reciprocal inhibition, which for the piriformis muscles, is done by contracting the antagonistic medial rotator muscles without allowing any medial rotation movement of the thigh. After relaxation, the slack in the piriformis muscles is then passively taken up by increasing medial rotation. According to Moreau and Nook (1995), reciprocal inhibition is the first neurophysiologic principle of the Contract - Relax - Antagonist - Contract (C.R.A.C.)

technique of Proprioceptive Neuromuscular Facilitation (P.N.F.) muscle stretching, while the second principle is called post isometric inhibition. Both these principles are in agreement with Liebenson (1989).

McAtee (1993:11) found that in eight out of the fourteen studies he reviewed, P.N.F. stretching was more effective for increasing range of motion and flexibility than static, ballistic or passive stretching. Sady et al. (1982) also compared the effects of static, ballistic, and P.N.F. stretching techniques on muscle flexibility. The study was performed on the shoulder, trunk and hamstring muscles, and it was found that only the C.R.A.C. technique of P.N.F. muscle stretching significantly increased range of motion compared to the control group.

Prentice (1983) compared static stretching and P.N.F. for increasing flexibility at the hip and found that, although both methods were effective, P.N.F. was significantly better than static stretching. Moore and Hutton (1980) used electromyography on the hamstring muscles to investigate the difference between static stretching and two P.N.F. techniques (Contract - Relax and C.R.A.C.), and concluded that the C.R.A.C. stretches were most effective for improving muscle flexibility.

2.8. Contra-indications to Spinal Manipulative Therapy

Manipulation cannot be performed on all patients. Chiropractors should therefore consider the contra – indications to spinal manipulative therapy before attempting to adjust any patient (Wyatt 1992:199).

There are absolute and relative contra – indications to S.M.T. Absolute contra – indications exclude the patient from all dynamic high force manipulation, and according to Wyatt (1992:200) they are as follows:

1) Benign bone tumours
2) Cord tumour
3) Dislocation
4) Fracture (acute)
5) Inflammatory arthritis (acute)
6) Infection (osteomyelitis/ septic discitis)
7) Instability
8) Haematoma (cord or intracellular)
9) Malignancy
10) Meningeal tumour
11) Myelopathy
12) Radiculopathy (with atrophy/ severe muscle weakness)

Absolute contra – indications specifically pertaining to the lumbar spine:

13) Aortic aneurysm (dissecting type)

14) Cauda equina syndrome

Relative contra – indications to S.M.T. are those conditions that mandate that the type and/or force of manipulation must be altered to prevent serious injury to the patient. Wyatt (1992:201,202) lists these as follows:

1) Anti – coagulant therapy
2) Benign bone tumours (non - aggressive types)
3) Fibrous dysplasia
4) Haemangioma
5) Cerebrovascular accident (history of)
6) Clotting/ bleeding disorders
7) Spinal canal stenosis
8) Intervertebral foraminal stenosis
9) Fracture (healed injury without instability)
10) Lateral recess stenosis
11) Osteoporosis
12) Pregnancy
13) Seizures
14) Spondylolisthesis (progressive unstable types)
15) Syringomyelia

Geirenger et al. (1988:283) adds the following absolute contra – indications of S.M.T.:

1) Abdominal aneurysm
2) Aseptic necrosis
3) Severe diabetes
4) Vertebral joint instability
5) Spinal deformity (severe kyphosis or scoliosis)
6) Cauda equina syndrome
7) Atherosclerosis
8) Ligamentous instability

2.9. Contra – indications to P.N.F. stretching

According to Nook and Mierau (1992), therapeutic stretching should not be performed if there is a lack of stability of any articulations involved in the stretch, or if there is evidence of acute soft tissue or muscle injury near the area to be stretched.

2.10. Summary of the literature review

Anatomists have only recently uniformly agreed that the sacro – iliac joint is truly diarthrodial (synovial) and not amphiarthrodial or synarthrodial (Bernard and Cassidy 1991). This is significant in that diarthrodial joints are subject to reversible blockages that occur within their range of motion (Panzer and Gatterman 1995:453). According to Cassidy (1992), only recent studies have detailed the sacro – iliac joint with a unique developmental anatomy, which is responsible for an unusual and underdeveloped iliac cartilage surface.

According to Panzer and Gatterman (1995:453), there exists between three to five degrees of motion in the sacro – iliac joints and until recently, the sacro - iliac joints were not considered mobile enough to cause significant dysfunction as a result of restricted motion. Cassidy (1992) states that the biomechanical function of the sacro – iliac joint and its role in the pathogenesis of low back pain are not clear.

There is wide acceptance of manipulation as an effective conservative treatment for low back pain, which is most likely due to the relatively high number of controlled clinical trials available in the literature (Cassidy et al. 1992:292). Specific manipulative therapy directed at the sacro – iliac articulation is the treatment of choice for sacro – iliac syndrome (Cassidy and Mierau 1992:221).

According to Liebenson (1989), the original active muscular relaxation techniques (which are the P.N.F. techniques) may indirectly mobilise a joint or at the very least make an adjustment more comfortable and long lasting for the patient when overactive or shortened muscles are related to a specific joint dysfunction. Their main application therefore is to directly treat the muscular component to enhance the efficacy of the adjustment. Liebenson (1989) concludes by stating that appropriately delivered spinal adjustments may be all that is necessary to normalise neural and circulatory activity (due to the rich innervation of the facet joint capsules), but in many cases, a broader treatment is required.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. The Sample

The study was limited to patients from the province of Kwazulu - Natal who responded to advertisements placed at the Technikon Natal Chiropractic Day Clinic, Technikon Natal Campus, as well as local gyms, sports clubs and daily newspapers. Patients who presented at the Technikon Natal Chiropractic Day Clinic with mechanical lower back pain were considered for the study. The study was however limited to patients suffering from sacro - iliac syndrome. No stratification of the patients took place and they were accepted without criteria regarding gender, occupation, race, severity or chronicity of the condition.

Patients were randomly allocated into either Group one or Group two, depending on whether they chose a piece of paper out of a hat with the number one or two on it, until each group had thirty patients. Group one was the control group and received chiropractic manipulation of the sacro - iliac joint alone. Group two was the experimental group and patients in this group received chiropractic manipulation of the symptomatic sacro - iliac joint followed by P.N.F. stretching of the piriformis muscle on the side of the sacro – iliac syndrome.

3.2. The Method

An initial screening consultation was conducted in order to make a diagnosis of sacro – iliac syndrome. According to the Kirkaldy - Willis model (Kirkaldy - Willis and Burton 1992:124), patients had to test positive for at least two of the three sacro- iliac joint stress tests namely, Gaenslen's, Yeomann's and Patrick Faber's tests. The same screening procedure was used for this study, and if the diagnosis of sacro - iliac syndrome could not be made, those patients were excluded from the study.

The patients selected for the study received a letter of information (APPENDIX A) at the initial consultation. The letter served to explain the research procedure to each patient. All patients were also required to complete an informed consent form (APPENDIX B) before undergoing the initial consultation. Patients in both groups underwent an initial consultation consisting of a full case history (APPENDIX E), physical examination (APPENDIX F) and lumbar spine and pelvis regional examination (APPENDIX G). Once the diagnosis of sacro - iliac syndrome was confirmed, both groups underwent a series of four treatments within a two – week period.

Subjective measurements included the Numerical Pain Rating Scale (Jensen et al. 1986) (APPENDIX C) and the Oswestry Low Back Pain Disability Index questionnaire (Fairbank et al. 1980) (APPENDIX D). These measurements were completed by each patient prior to the first and second treatments, and immediately following the fourth treatment.

Objective measurements included Gaenslen's, Yeomann's and Patrick Faber's orthopaedic tests (Kirkaldy - Willis and Burton 1992:124), as well as inclinometer and algometer readings. These measurements were recorded by the researcher prior to the first and second treatments, and immediately following the fourth treatment.

Patients who became asymptomatic in terms of subjective clinical findings before the fourth (final) treatment, received no further treatment. The patients were however required to return for all remaining consultations for observational purposes. If a patient's condition became subjectively worse as a result of treatment, their condition was re - evaluated before continuing treatment, and if necessary, the patient's treatment was terminated and the data excluded from the study.

The precise nature and implications of the study were explained to each patient and no patients were coerced into participation. Patients in both groups received an established and widely used form of treatment for low back pain in terms of manipulation. Patients were informed that they were free to withdraw from the study at any stage and without reason. All patient information was treated with confidentiality.

3.3. Inclusion and Exclusion Criteria

3.3.1. Inclusion Criteria

1) Patients between the ages of 18 and 60 years were accepted into the study.

2) Patients had to test positive for at least two out of three sacro - iliac orthopaedic tests, namely Gaenslen's, Yeomann's and Patrick Faber's tests (Kirkaldy - Willis and Burton 1992:124,125).

3) Secondary, concomitant mechanical conditions to the sacro - iliac syndrome (eg. latent myofascial involvement and/or lumbar facet syndrome) did not exclude patients from the study, although these conditions were not treated.

3.3.2. Exclusion Criteria

1) Patients younger than 18 years and older than 60 years were excluded from the study. Patients older than 60 years were excluded due to the possibility of the development of fibrous ankylosis in the sacro - iliac joint after the sixth decade (Kirkaldy-Willis et al. 1992:123).

2) Patients who presented with active myofascial trigger points (Travell and Simmons 1992) which were symptomatic and referring pain in a similar distribution to the sacro - iliac syndrome, were excluded from the study.

3) Patients who presented with a lumbar facet syndrome as the primary causative factor of their low back pain were not accepted into the study.

4) Patients who presented with signs of nerve root tension were not accepted into the study.

5) Patients who used pain and/or anti – inflammatory medication, or who received any additional low back treatment during the two week treatment period, were excluded from the study.

6) Patients with suspected contra – indications to spinal manipulation were not considered for the study. Absolute and relative contra – indications to spinal manipulation are described in chapter two by Wyatt (1992:201,202), as well as Geirenger et al. (1988:283).

7) Patients with suspected contra – indications to P.N.F. stretching were not accepted into the study. These are described in chapter two by Nook and Moreau (1992).

8) Pregnant females were excluded from the study, as hormone - induced ligament laxity and possible resultant instability of the sacro - iliac joints as well as pain, occurring during pregnancy. (Vleeming et al. 1990b).

3.4. Location of the Data

3.4.1. The Primary Data

The Primary data was obtained from the Numerical Pain Rating Scale 101 (Jensen et al. 1986), and the Oswestry Low Back Disability Index (Fairbank et al. 1980) questionnaires. The patient's pressure threshold was measured with a Wagner FDK20 algometer. Orthopaedic sacro - iliac stress tests were performed, while the flexibility of the piriformis muscles was assessed by adapting the Piriformis Test (Magee 1992:355).

3.4.2. The Secondary Data

The secondary data was obtained from books, journal articles, and the Internet (Medline and Pubmed).

3.5. Measurements

Measurements recorded consisted of both subjective and objective criteria. All measurements were recorded prior to the first and second treatments, and immediately following the fourth treatment.

3.5.1. Subjective Measurements

Subjective measurements were recorded in the form of two written questionnaires, namely the Numerical Pain Rating Scale 101 (Jensen et al. 1986), and the Oswestry Low Back Pain Disability Index (Fairbank et al. 1980).

3.5.1.1.Numerical Pain Rating Scale 101

The 101 - point Numerical Pain Rating Scale (Jensen et al. 1986) is a questionnaire used to measure the intensity of pain a patient is experiencing. The patient was required to indicate by means of a percentage their intensity of pain on a scale of 0 to 100, where 0 represents 'no pain', and 100 represents 'pain as bad as it could be'. The pain intensity was recorded when the pain was at its least as well as when it was at its most intense. The average between these two figures was calculated, and this was an indication of the patient's level of pain.

A study conducted by Jensen et al. (1986), in which six methods of evaluating pain intensity were compared, concluded that the Numerical Pain Rating Scale was superior to all other measures. This conclusion was drawn due to its simple and practical method of administering and scoring, either in written or verbal form, as well as the fact that the results did not seem to be dependant on age. The six methods of pain evaluation were compared according to five criteria. These were, ease of administration of the scoring, relative rate of incorrect responding, sensitivity with regard to questions, sensitivity of statistical analysis, and relationship to a combination of pain intensity indices.

Downie et al. (1978) compared four pain - rating scales. These were the Simple Descriptive Scale (S.D.S.), the vertical and horizontal Visual Analogue Scales (V.A.S.), and the Numerical Pain Rating Scale (N.R.S.). The N.R.S. was considered advantageous over the three other pain - rating scales, in terms of accuracy. A more recent study by Bolton and Wilkinson (1998) compared three pain scales on 79 chiropractic patients. The pain scales compared were the V.A.S, the Verbal Rating Scale and the N.R.S., and it was found that the N.R.S. was the most responsive. The authors recommended this questionnaire for most types of outcome studies.

3.5.1.2. The Oswestry Low Back Pain Disability Index

The Oswestry Low Back Pain Disability questionnaire (Fairbank et al. (1980) was completed by patients in order to assess limitations of various activities of daily living. The questionnaire is divided into 10 sections selected from a series of experimental questionnaires. There are six statements in each section, and each statement describes a greater degree of difficulty in that activity, than the preceding statement. The questionnaire allows a maximum score of five and a minimum score of zero in each section. The total score is out of 50, which is then multiplied by two in order to represent a percentage of disability.

Kirkaldy - willis and Burton (1992:92) stated that the Oswestry Low Back Pain Disability Index was the best way of assessing the pain and disability of low back pain. In a review of the quality of four disease - specific questionnaires, Beurskens et al. (1995) concluded that the Oswestry Low Back Pain Disability Index was a valuable outcome measure for the assessment of low back pain. The same authors do, however, point out some unfavourable characteristics of the Oswestry Index. These are the inclusion of both performance based and capacity based questions, which make it unclear for the patient to answer whether they can perform the action or whether they think they can perform the action. The time frame regarding the pain and disability was also left undefined, a problem also identified by Enebo (1998). Patients in this study were asked to answer each successive Oswestry questionnaire with regards to any changes in their pain perception since the previous treatment.

3.5.2. Objective Measurements

Objective measurements were recorded from algometer and inclinometer readings, as well as the three orthopaedic pain provocation tests for the sacro – iliac joints, namely Gaenslen's, Yeomann's and Patrick Faber's tests (Kirkaldy - Willis and Burton 1992:124).

3.5.2.1. The Algometer

The algometer used in this trial was the Wagner FDK20 Force Dial. (Wagner Instruments, P.O. Box 1217, Greenwich, CT, 06836 USA, tel. 2038699861). The algometer measures pressure threshold , which Fischer (1987) described as the minimum pressure or force that induces pain or discomfort. The force readings were measured in kilograms per square centimetre.

The algometer used in this study was fitted with a one - centimetre rubber disc, which Fischer (1986) considered more suitable to assess tenderness in tendons, ligaments and joint capsules. The patient was asked to say 'now' at the point where the pressure sensation became a sensation of pain or discomfort. The algometer reading at that point was then recorded. The dial was set to zero before recording each reading, by pressing the rest button.

Fischer (1986) confirmed the validity of algometer measurements in evaluating manipulative intervention, stating that the algometer can be used to quantify the patient's response to manipulation. He concluded by stating that the reproducibility of pressure threshold measurements indicates that the records of pain intensity are reliable.

3.5.2.2. Orthopaedic Tests

Three orthopaedic tests were used to confirm the diagnosis of sacro - iliac syndrome. These were Patrick Faber's test, Gaenslen's test and Yeomann's test, described according to the Kirkaldy - Willis model of classifying sacro - iliac syndrome (1992:124,125).

Patrick Faber's test was performed with the patient supine. The right leg, at the ankle, was placed in front of the left thigh above the knee. The examiner placed his right hand over the patient's left iliac crest, while the examiner's left hand pushed downward on the medial aspect of the right knee. A positive test was recorded if this position elicited pain over the region of the right sacro - iliac joint. Giles and Singer (1997:397) described Patrick Faber's test in chapter two.

Gaenslen's test was performed with the patient supine. The examiner flexed the patient's left knee and hip, while pressing downward over the right thigh to hyperextend the right hip. A positive test was recorded if this position elicited pain over the region of the right sacro - iliac joint. Giles and Singer (1997:397) also described Gaenslen's test in chapter two.

Yeomann's test was performed with the patient prone. The examiner placed one hand under the right thigh above the knee on the affected side, to extend the right hip. The examiner's other hand presses downward over the crest of the right ilium. A positive test was recorded if this position elicited pain over the region of the right sacro - iliac joint. Yeomann's test was also described by Panzer and Gatterman (1995:460) in chapter two.

Each test scored positive if it induced pain over the sacro - iliac joint, and was allocated one point. A negative result was recorded as zero points if the patient expressed 'no pain' or pain in the lumbar spine, hip joint, or any site other than the sacro – iliac joint.

3.5.2.3. Piriformis muscle flexibility

The Piriformis muscle flexibility was assessed objectively by adapting the Piriformis Test (Magee 1992:355). The technique was performed as follows:

The patient was in the side - lying position with the test leg uppermost. The patient then flexed the test hip to 60 degrees. The lower leg was secured to the table using a velcro strap over the thigh. A second strap was placed over the anterior iliac spine of the test hip to ensure pelvic stabilisation.

An electronic inclinometer, supplied by Saunders Therapy Products (Bloomington, MN 551100 - 4144), was secured on the lateral thigh of the test leg, midway between the greater trochanter and the lateral femoral condyle. The examiner provided added stabilisation to the hip with one hand and applied a downward pressure to the knee with the other hand. When the piriformis muscle became tight at the point of restriction, the angle between the horizontal and the test thigh was recorded. The inclinometer responded to gravity, thus measuring the gradient in degrees.

3.6. Interventions

3.6.1. Motion Palpation

Motion palpation was used to establish the site of the manipulable lesion, and not to diagnose the sacro – iliac syndrome or to determine the outcome of the treatment administered. Motion palpation of the sacro - iliac joint was conducted using the Gillet method, as described by Schafer and Faye (1989:260):

In order to screen iliac flexion and extension on the sacrum in the standing position, the examiner's thumbs were placed on the patient's P.S.I.S.'s. The patient was then asked to raise the right knee up towards the chest, and then down, bending the knee as if taking a high step. The right P.S.I.S. was felt to arc posteriorly and inferiorly. After about 20° of leg raise, the patient's left P.S.I.S. dropped backward and downward. This is normal sacro – iliac motion. Any motion other than this indicated a problem in the joint. The test was repeated by having the patient raise the left knee up and down. If the joint was fixated the pelvis tended to remain level, or possibly raise rather than drop. According to Schafer and Faye (1989:260), these signs of thumb movement can be seen as well as felt.

In order to evaluate standing superior joint motion, one thumb was placed on the patient's sacral base and the other thumb on the P.S.I.S. of the side being tested. The patient was asked to raise the flexed knee of the side being tested up towards the chest, as if taking a high step, and the separation of the thumbs was noted. The sacral base normally arcs anteriorly and inferiorly, or conversely, the P.S.I.S. moves backward and downward. The test was repeated with the patient raising the opposite knee. If the superior sacro – iliac joint is locked, the sacrum and ilium move as a unit and the thumbs will not separate appreciably, while the sacral tissues remain taut.

In order to evaluate standing inferior joint motion, one thumb was placed on the patient's sacral apex and the other thumb on the ischial protuberence. The patient was asked to raise the flexed knee of the side being tested, as if taking a high step, and the separation of the thumbs was noted. The ischium should move antero – superiorly and slightly lateral on the sacrum. If the inferior joint is locked, the ischium and sacral apex move as a unit and there is therefore no separation of the thumbs.

It is interesting to note that Schafer and Faye (1990:260) state that the direct cause of this type of fixation is usually failure of the muscles acting on the sacral apex to stretch, of which piriformis muscle contracture is a common cause.

3.6.2. Manipulation

The fixated sacro – iliac joint was manipulated according to the Diversified Technique (Schafer and Faye 1990:282,283; Bergmann 1993:500,501). The standard side posture method of manipulation (with the involved side upward) was delivered to the fixated sacro - iliac joint, at either the upper or lower aspect.

Schafer and Faye (1990:282,283) described the side posture technique as follows:

For a fixation at the upper aspect of the sacro – iliac joint, the patient was in the lateral recumbent position with the involved ilium facing upward. The patient's uppermost knee was flexed to the maximum. The patient's lumbars and shoulders were maintained in a neutral position, while contact of the active hand was applied to the P.S.I.S. of the involved joint. The patient's uppermost shoulder was supported with the stabilising hand. Applying a downward pressure against the patient's flexed knee with the researcher's knee opened the posterior aspect of the sacro – iliac joint. An impulse with a body drop was delivered with the active hand, directed at the area of fixation.

For a fixation at the lower aspect of the sacro – iliac joint, the patient was in the lateral recumbent position with the involved ilium facing upward. The patient's uppermost knee was flexed to the maximum. The patient's lumbars and shoulders were maintained in a neutral position, while contact of the active hand was applied to the ischium. The patient's uppermost shoulder was supported with the stabilising hand. Applying a downward pressure against the patient's flexed knee with the researcher's knee opened the posterior aspect of the sacro – iliac joint. An impulse with a body drop was delivered with the active hand, to rotate the involved ilium.

3.6.3. Proprioceptive Neuromuscular Facilitation

Proprioceptive Neuromuscular Facilitation (P.N.F.) stretches were performed on the ipsilateral piriformis muscle to the side with the sacro - iliac joint dysfunction. The Contract - Relax - Antagonist - Contract (C.R.A.C.) technique, described by Moreau and Nook (1995) was used in this study.

Stretch Position:

The patient was on their back with one leg crossed over the other, with the bottom of the foot of the crossed leg on the floor next to the opposite hip. The researcher then knelt next to the patient's foot on the floor. The researcher placed one knee next to the side of the patient's foot and then pushed the patient's flexed knee up towards the shoulder of the patient on the same side. The researcher then placed their other foot next to the patient's straightened knee in order to separate the patient's foot and knee. The researcher then leant their chest into the patient's leg, pushing the crossed leg and knee towards the patient's opposite shoulder until the patient felt a stretch in the crossed leg's buttock.

Contraction Phase:

The patient then pushed their crossed knee out against the researcher's chest for a count of eight seconds, thus contracting the piriformis muscle.

Relaxation Phase:

The researcher and patient stopped pushing. The patient did not uncross their leg, but relaxed in the stretch position.

Antagonist Contraction Phase:

The patient then pushed their knee further up towards the opposite shoulder until they felt a stretch in their buttock, thus contracting the antagonist medial rotator muscles.

Stretch Phase:

The researcher then moved their knee that was against the patient's foot up towards the patient's shoulder and then leant into the patient's leg, moving it up towards the patient's opposite shoulder. This was done until a stretch was felt again in the patient's buttock. The patient then pushed out against the researcher's chest again, starting at the next set of P.N.F. stretches. This was repeated for a total of three sets.

3.7. Statistical Analysis of the Data

Statistical analysis was conducted on the subjective and objective data collected using the SPSS software programme, and was presented in the form of bar graphs and tables.

Parametric and non - parametric testing was used in order to analyse the data. Parametric tests included the oneway ANOVA Tests and the Unpaired T - Tests. The Bonferroni tests were part of the oneway ANOVA tests and represented comparisons made between two treatments at a time only. Non - parametric tests included the Mann - Whitney and Wilcoxon's Signed Rank tests. The level of significance for all tests was set at 5% (α = 0.05.)

3.7.1. Parametric and Non – Parametric Testing

Parametric tests were conducted to analyse the continuous variables while non - parametric tests were conducted to analyse the categorical variables (Fisher 1993).

3.7.1.1. Parametric Testing

The continuous variables analysed included results from the Numerical Pain Rating Scale 101 (Jensen et al. 1986), algometer readings, as well as the inclinometer readings from the adapted Piriformis Test. Means, ranges, standard errors and standard deviations were used for analysis.

Subjective and objective data from the results of the continuous variables were analysed using the Two - Sample Unpaired T - Test for inter - group comparisons. This was in order to determine whether any significant difference existed between the mean values within the control and experimental groups at the first, second and fourth consultations.

Subjective and objective data from the continuous variables was also analysed using the Bonferroni Test for intra - group comparison. This was in order to determine whether any significant change occurred between the mean values within each group of the first, second and fourth consultations.

3.7.1.2. Non - Parametric Testing

The categorical variables analysed included results from the Oswestry Low Back Disability Index (Fairbank et al. 1980), as well as the three orthopaedic sacro – iliac stress tests.

Subjective and objective data from the results of the Oswestry Low Back Disability questionnaire and the orthopaedic tests were analysed using the Mann - Whitney U - Test for inter - group comparisons. This was in order to determine whether there was any significant difference in the mean, median, and standard deviation values in the control and experimental groups at the first, second and fourth consultations.

Subjective and objective data, from the categorical variables was analysed using the Wilcoxon Signed Rank Test for intra - group comparisons. This was in order to determine whether there was any significant difference in the mean, median, and standard deviation values in the control and experimental groups at the first, second and fourth consultations.

3.7.2. Treatment of each objective

Statistical analysis was conducted on the subjective and objective data collected. The results obtained from the data were then used to solve each of the objectives.

3.7.2.1. Objective One

The first objective was to determine the relative effectiveness of sacro - iliac joint manipulation versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, in terms of subjective clinical findings.

The null hypothesis for Objective One:

The null hypothesis states that there would be no significant difference between manipulation of the sacro - iliac joints versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, upon analysis of the subjective inter-group data, showing that both methods were equally reliable.

The alternative hypothesis for Objective One:

The alternative hypothesis_states that there would be a significant difference between manipulation of the sacro - iliac joints versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, upon analysis of the subjective inter-group data, showing that both methods were not equally as reliable.

3.7.2.2. Objective Two

The second objective was to determine the relative effectiveness of sacro - iliac joint manipulation versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, in terms of objective clinical findings.

The null hypothesis for Objective Two:

The null hypothesis states that there would be no significant difference between manipulation of the sacro - iliac joints versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, upon analysis of the objective data, showing both methods were equally reliable.

The alternative hypothesis for Objective Two:

The alternative hypothesis states that there would be a significant difference between manipulation of the sacro - iliac joints versus sacro - iliac joint manipulation in conjunction with the P.N.F. (C.R.A.C.) technique of piriformis muscle stretching, indicating that both methods were not equally reliable.

3.7.2.3. Objective Three

The third objective was to integrate the data from the two sacro - iliac joint treatment protocols, in terms of subjective and objective measures, in order to determine which is the most effective means of treatment of sacro - iliac syndrome.

The null hypothesis for Objective Three:

The null hypothesis states that there would be no significant difference between the subjective and objective clinical findings on analysis of the inter-group and the intra-group data showing that the methods of analysis were equally reliable.

The alternative hypothesis for Objective Three:

The alternative hypothesis states that there would be a significant difference between the subjective and objective data on analysis of the inter-group and the intra-group data showing that the methods of analysis were not equally reliable.

CHAPTER FOUR

4. THE RESULTS

4.1. The Sample Size

The sample size of the study was limited to 60 patients, with 30 patients in each of the two groups. Group one was the first treatment group, which received manipulation of the sacro - iliac joints alone. Group two was the second treatment group, which received manipulation of the sacro - iliac joints in conjunction with proprioceptive neuromuscular facilitation stretching of the piriformis muscles.

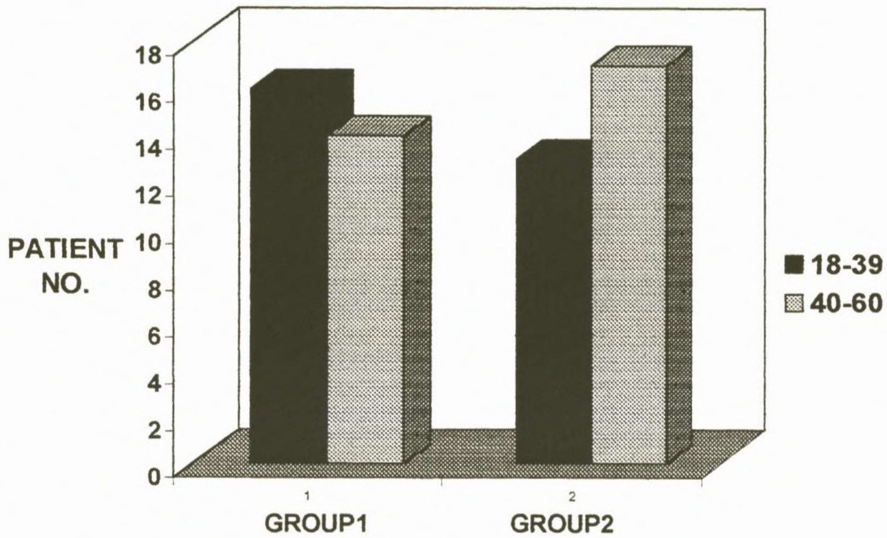
110 patients responded to the newspaper advertisements for the treatment of low back pain. These patients were screened telephonically according to the study criteria. 83 of the original 110 patients were then assessed at the Technikon Natal Chiropractic Day Clinic, of which 68 patients satisfying the selection criteria were accepted into the study. Eight patients had to be excluded from the study during the course of treatment because of non - compliance. The number of patients who completed the study and contributed to the statistical data was therefore 60.

4.2. Demographics

Demographical data including age and gender distribution, as well as the side of the sacro - iliac syndrome, are represented in the form of bar graphs.

4.2.1. Age Distribution

Figure 4.1. Age Distribution

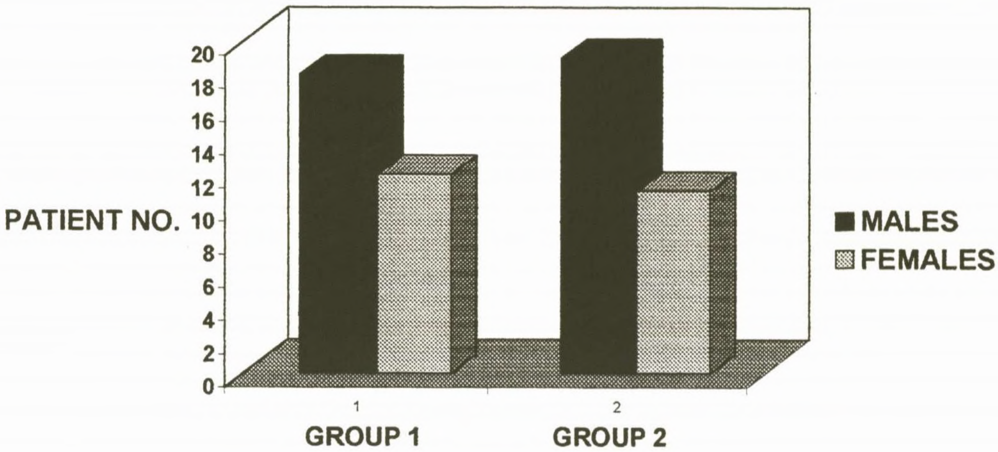


The mean age of Group 1 was 38.2 years, while the mean age of Group 2 was 42 years. The overall mean age of both groups was 40.1 years.

The mean age of patients within this study is consistent with the literature, as Gemmel and Jacobson (1990) report that it is generally accepted that episodes of low back pain have the highest frequency of symptoms occurring between the ages of 35 and 55.

4.2.2. Gender Distribution

Figure 4.2. Gender Distribution



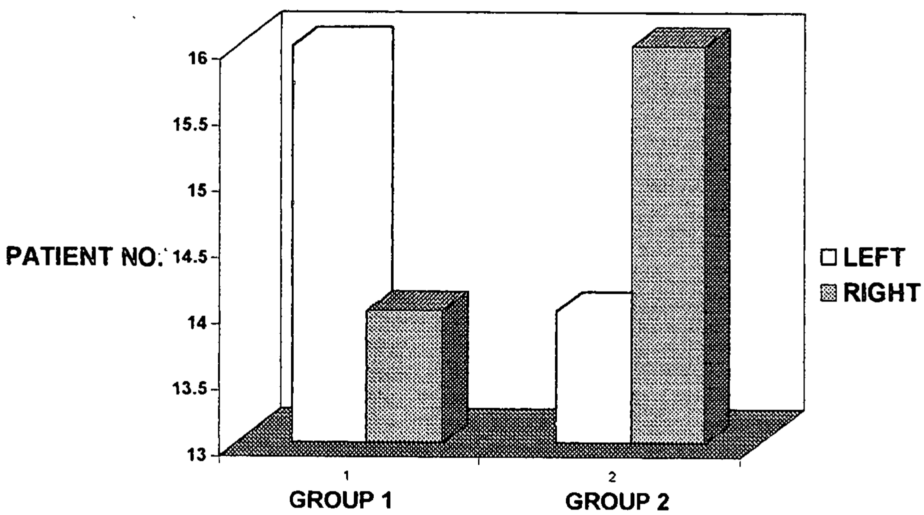
Both treatment groups consisted of more males than females. The number of males to females in Group 1 was 18:12, while the number of males to females in Group 2 was 19:11. The overall number of males to females within both groups was 37:23.

According to the literature, there is a female to male preponderance of sacro - iliac syndrome in the general population (Gemmel and Jacobson 1990, Cibulka and Koldehoff 1999).

Daum (1995) states that the typical patient with sacro - iliac joint dysfunction is a woman (middle - aged). This was a conclusion drawn from two low back pain studies, namely Bernard and Cassidy (1991) and Bernard and Kirkaldy - Willis (1987).

4.2.3. Side of the sacro - iliac syndrome

Figure 4.3. Side of the sacro - iliac syndrome



The number of left to right sacro - iliac joint cases in Group 1 was 16:14, while the number of left to right sacro - iliac joint cases in Group 2 was 14:16. The overall number of left to right sacro - iliac joint cases within the sample size was therefore exactly equal, at 30:30.

Toussaint et al. (1999) found a 60:40 right - sided predominance of sacro - iliac joint dysfunction in a cross - section study of a group of 480 construction workers. In a study of 100 cases of sacro - iliac subluxation, Xiadong and Yonggang (1994) found a 58:42 left - sided predominance of sacro - iliac joint involvement.

According to Bernard and Cassidy (1991:2115) however, symptoms of sacro - iliac joint dysfunction usually have a right - sided predominance and are also usually unilateral. Schwarzer et al. (1995) maintains that the condition is likely to be unilateral in about 60% of the patients.

Only three cases of bilaterally symptomatic sacro - iliac joints were found within this study, representing 5% of the sample size. Therefore, bilateral involvement of the sacro - iliac joints was not analysed. Of the three cases, only the side with the predominant symptoms and predominantly positive orthopaedic sacro - iliac joint stress tests was treated and analysed.

It is interesting to note that in the study by Toussaint et al. (1999), bilateral sacro - iliac dysfunction was not recorded. Xiadong and Yonggang (1994) studied 100 cases of sacro - iliac subluxation and similarly, found no cases of bilateral sacro - iliac joint involvement.

4.2. Analysis of the Data

Parametric and non - parametric testing was used in order to analyse the data. Parametric tests included the oneway ANOVA Tests and the Unpaired T - Tests. The Bonferroni tests were part of the oneway ANOVA tests and represented comparisons made between two treatments at a time only. Non - parametric tests included the Mann - Whitney and

Wilcoxon's Signed Rank tests. The level of significance for all tests was set at 5% (α = 0.05.)

4.3.1. Parametric testing: A comparison of the continuous variables

4.3.1.1. Inter - group analysis: Two - Sample Unpaired T - Tests

Table 4.1. Statistical results comparing Group 1 and Group 2 in terms of subjective and objective measurements from Treatment 1

	GROUP 1				GROUP 2		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.4233	0.9825	0.1794	0.959	3.4367	1.0033	0.1832
N.R.S.	41.1167	13.2351	2.4164	0.825	40.4167	11.1240	2.0310
Inclin.	29.6133	7.3158	1.3357	0.66	33.4733	8.5862	1.5676

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$ (two - sided test). There was therefore no statistically significant difference between Group 1 and Group 2 at the 1st treatment for all results. This indicates that patients from both groups entered the study with similar levels of low back disability and pain pressure threshold, as well as piriformis muscle flexibility.

Table 4.2. Statistical results comparing Group 1 and Group 2 in terms of subjective and objective measurements from Treatment 2

	GROUP 1				GROUP 2		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.7800	0.9510	0.1736	0.453	3.6067	0.8225	0.1502
N.R.S.	37.2333	12.5153	2.2850	0.807	36.3833	14.2984	2.6105
Inclin.	31.1167	7.6771	1.4016	0.62	34.7867	7.2530	1.3242

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$. There was therefore no statistically significant difference between Group 1 and Group 2, recorded at the 2nd treatment. This indicates that patients from the two groups showed no differences in the level of low back disability and pain pressure threshold, as well as piriformis muscle flexibility, following the first treatment.

Table 4.3. Statistical results comparing Group 1 and Group 2 in terms of subjective and objective measurements from Treatment 4

	GROUP 1				GROUP 2		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	4.0133	0.9213	0.1682	0.899	4.0433	0.9096	0.1661
N.R.S.	20.1667	16.7231	3.0532	0.85	27.5000	15.6745	2.8618
Inclin.	33.5667	7.5232	1.3735	0.62	36.6900	7.3808	1.3475

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$. There was therefore no statistically significant difference between Group 1 and Group 2 at the 4^{th} treatment for all results. Patients from the two groups showed no differences in the level of low back disability and pain pressure threshold, as well as piriformis muscle flexibility, following the fourth and final treatment. This indicates that both treatment protocols were equally effective in the treatment of sacro - iliac syndrome.

4.3.1.2. Intra - group analysis: Bonferroni Tests

Table 4.4. Statistical results comparing Treatment 1 and Treatment 2 in terms of subjective and objective measurements from Group 1

	TREATMENT 1				TREATMENT 2		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.4233	0.9825	0.1794	0.451	3.7800	0.9510	0.1736
N.R.S.	41.1167	13.2351	2.4164	0.885	37.2333	12.5153	2.2850
Inclin.	29.6133	7.3158	1.3357	1.000	31.1167	7.6771	1.4016

The null hypothesis was accepted for all results because $p>\alpha=0.05$ (one - sided test). There was therefore no statistically significant improvement in Group 1 between the 1^{st} and 2^{nd} treatment in terms of pain pressure threshold, pain intensity, and piriformis muscle flexibility.

Table 4.5. Statistical results comparing Treatment 2 and Treatment 4 in terms of subjective and objective measurements from Group 1

	TREATMENT 2				TREATMENT 4		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.7800	0.9510	0.1736	1.000	4.0133	0.9213	0.1682
N.R.S.	37.2333	12.5153	2.2850	**0.000**	20.1667	16.7231	3.0532
Inclin.	31.1167	7.6771	1.4016	0.629	33.5667	7.5232	1.3735

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was accepted for both the inclinometer and algometer readings because $p>\alpha=0.05$. There was therefore no statistically significant objective improvement in Group 1 between the 2nd and 4th treatment in terms of pain pressure threshold and piriformis muscle flexibility.

The null hypothesis for the Numerical Pain Rating Scale was rejected because $p<\alpha=0.05$. This indicates that there was a statistically significant subjective improvement in Group 1 between the 2nd and 4th treatment in terms of the levels of pain intensity.

The statistically significant mean difference in the N.R.S. readings of Group 1 from Table 4.5 is represented in the form of a bar graph in Figure 4.4.

Figure 4.4. Mean Difference for Group1 between Treatment 2 and Treatment 4

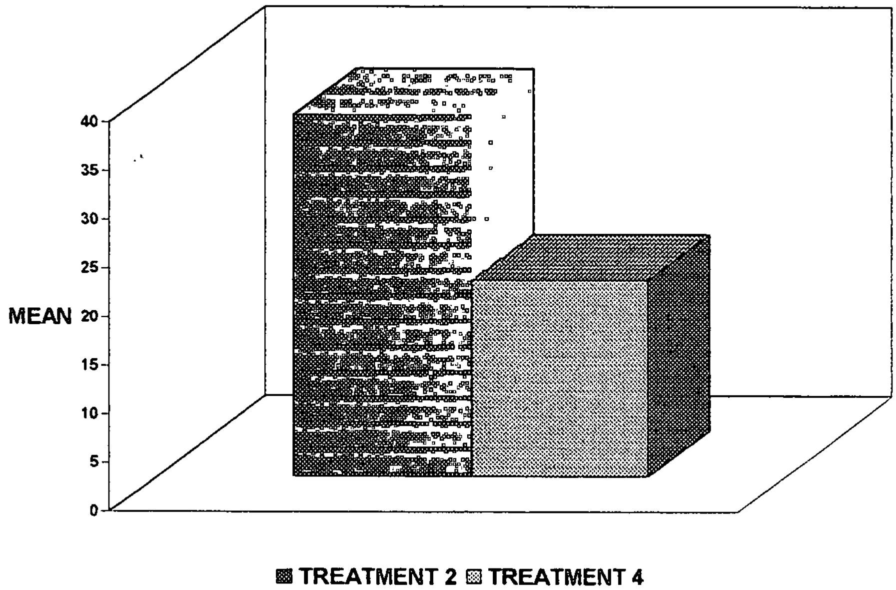


Figure 4.4. illustrates the statistically significant subjective improvement of patients in Group 1 in terms of the decrease in the levels of pain intensity between the 2nd and 4th treatment.

Table 4.6. Statistical results comparing Treatment 1 and Treatment 4 in terms of subjective and objective measurements from Group 1

	TREATMENT 1				TREATMENT 4		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.4233	0.9825	0.1794	0.56	4.0133	0.9213	0.1682
N.R.S.	41.1167	13.2351	2.4164	**0.00**	20.1667	16.7231	3.0532
Inclin.	29.6133	7.3158	1.3357	0.133	33.5667	7.5232	1.3735

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis for the inclinometer and algometer readings was accepted because $p>\alpha=0.05$. There was therefore no statistically significant improvement in Group 1 between the 1st and 4th treatment with regards to pain pressure threshold and piriformis muscle flexibility.

The null hypothesis for the results of the N.R.S. was rejected because $p<\alpha=0.05$. This showed a statistically significant subjective improvement in Group 1 between the 1st and 4th treatment with regards to the levels of pain intensity.

The statistically significant mean difference in the N.R.S. readings of Group 1 from Table 4.6 is illustrated in the form of a bar graph in Figure 4.5.

Figure 4.5. Mean Difference for Group1 between Treatment 1 and Treatment 4

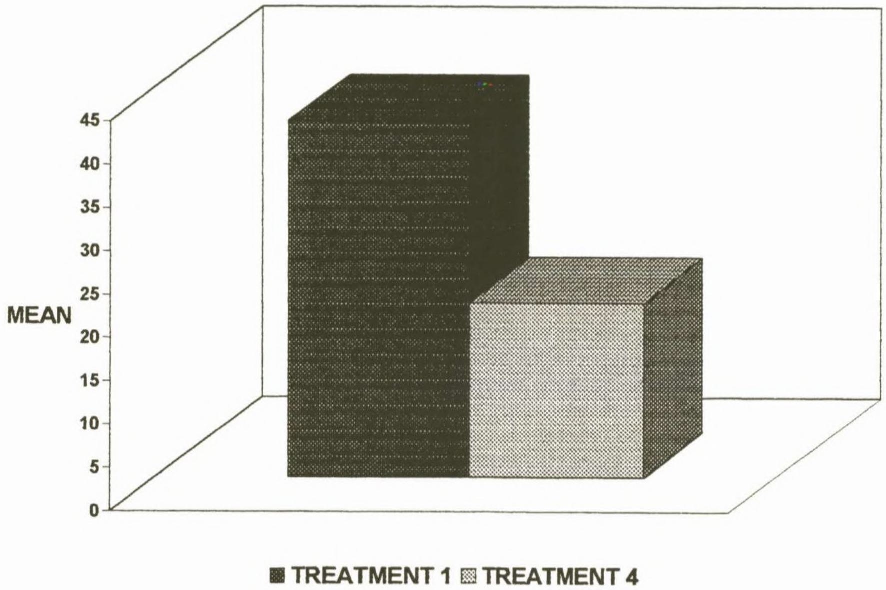


Figure 4.5 illustrates a marked statistically significant improvement with regards to the decrease in the levels of pain of patients in Group 1 between the 1^{st} and 4^{th} treatment.

It should be noted that this graph represents the overall effect of the treatment of Group 1 in terms of the subjective improvement in pain intensity, as measurements were recorded prior to the first treatment and following the fourth treatment.

Table 4.7. Statistical results comparing Treatment 1 and Treatment 2 in terms of subjective and objective measurements from Group 2

	TREATMENT 1				TREATMENT 2		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.4367	1.0033	0.1832	1.000	3.6067	0.8225	0.1502
N.R.S.	40.4167	11.1240	2.0310	0.785	36.3833	14.2984	2.6105
Inclin.	33.4733	8.5862	1.5676	1.000	34.7867	7.2530	1.3242

The null hypothesis was accepted for all results because $p>\alpha=0.05$. There was therefore no statistically significant improvement in Group 2 between the 1st and 2nd treatment with regards to pain pressure threshold, levels of pain intensity, and piriformis muscle flexibility.

Table 4.8. Statistical results comparing Treatment 2 and Treatment 4 in terms of subjective and objective measurements from Group 2

	TREATMENT 2				TREATMENT 4		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.6067	0.8225	0.1502	0.204	4.0433	0.9096	0.1661
N.R.S.	36.3833	14.2984	2.6105	**0.044**	27.5000	15.6745	2.8618
Inclin.	34.7867	7.2530	1.3242	1.000	36.6900	7.3808	1.3475

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis for the algometer and inclinometer readings was accepted because $p>\alpha=0.05$. There was therefore no statistically significant objective improvement in Group 2 between the 2nd and 4th treatment in terms of pain pressure threshold and piriformis muscle flexibility.

The null hypothesis for the N.R.S. readings was rejected because $p<\alpha=0.05$, showing a statistically significant subjective improvement in Group 2 between the 2nd and 4th treatment with regards to a decrease in the levels of pain intensity.

The statistically significant mean difference in the N.R.S. readings of Group 1 from Table 4.8 is illustrated in the form of a bar graph in Figure 4.6.

Figure 4.6. Mean Difference for Group 2 between Treatment 2 and Treatment 4

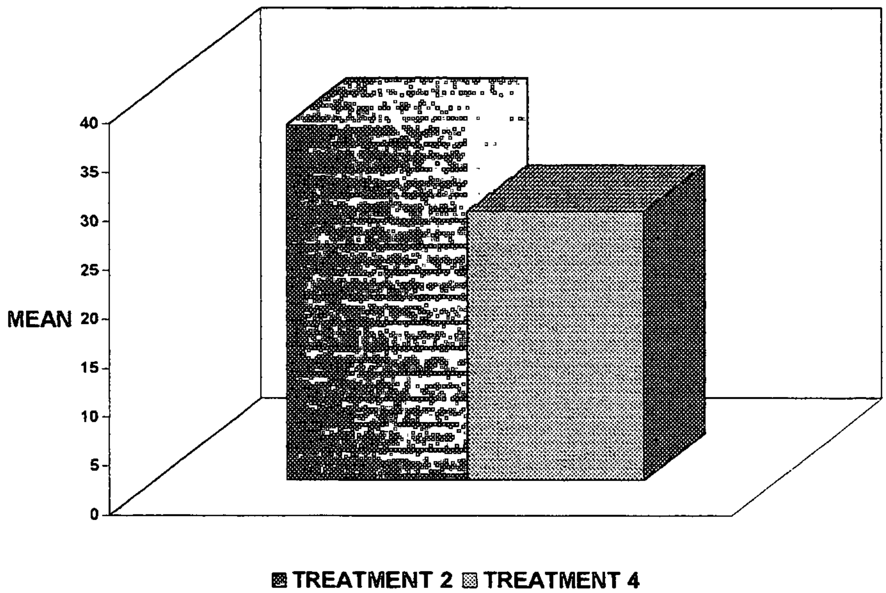


Figure 4.6. illustrates a statistically significant subjective improvement in Group 2 between the 2nd and 4th treatment in terms of a decrease in the levels of pain intensity.

Table 4.9. Statistical results comparing Treatment 1 and Treatment 4 in terms of subjective and objective measurements from Group 2

	TREATMENT 1				TREATMENT 4		
Test	Mean	S.D.	S.E.	P - Value	Mean	S.D.	S.E.
Algom.	3.4367	1.0033	0.1832	0.36	4.0433	0.9096	0.1661
N.R.S.	40.4167	11.1240	2.0310	**0.001**	27.5000	15.6745	2.8618
Inclin.	33.4733	8.5862	1.5676	0.337	36.6900	7.3808	1.3475

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was accepted for both the algometer and inclinometer readings because $p>\alpha=0.05$. There was therefore no statistically significant objective improvement in Group 2 between the 1st and 4th treatment with regards to pain pressure threshold and piriformis muscle flexibility.

The null hypothesis for the results of the N.R.S. was rejected because $p<\alpha=0.05$. This showed a statistically significant subjective improvement in Group 2 between the 1st and 4th treatment in terms of a decrease in the levels of pain intensity.

The statistically significant mean difference in the N.R.S. readings of Group 2 from Table 4.9 is illustrated in the form of a bar graph in Figure 4.7.

Figure 4.7. Mean Difference for Group 2 between Treatment 1 and Treatment 4

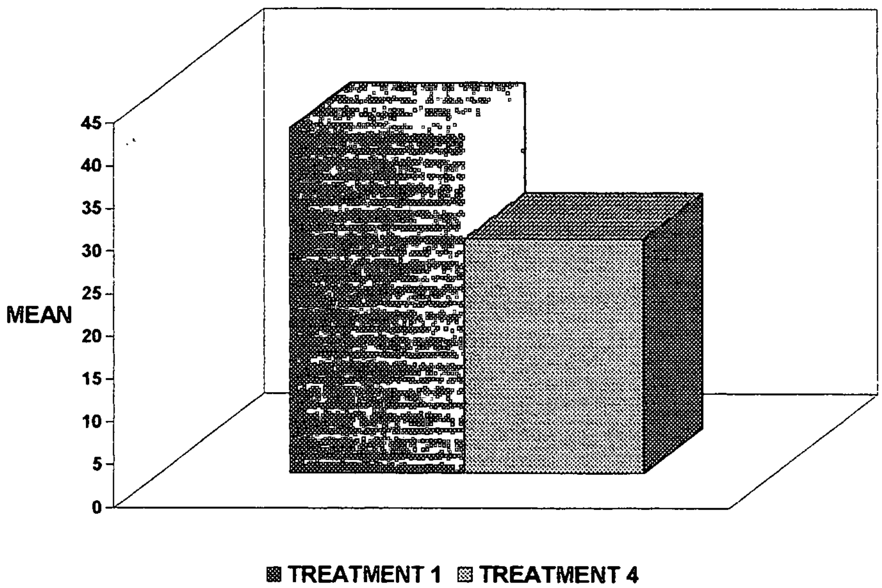


Figure 4.7. illustrates a statistically significant subjective improvement in Group 2 between the 1st and 4th treatment in terms of a decrease in the levels of pain intensity.

The overall mean difference with regards to the results of the N.R.S. readings for Group 2 (P = 0.001) is not as marked as that of Group 1 (P = 0.00), although both groups improved significantly.

4.3.2. Non - parametric testing: A comparison of the categorical variables

4.3.2.1. Inter - group analysis: Mann - Whitney U - Tests

Table 4.10. Statistical results comparing Group 1 and Group 2 in terms of objective measurements from Treatment 1

	GROUP 1				GROUP 2		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	18.13	19.00	8.44	0.481	20.53	19.00	10.70
S.I. tests.	2.27	2.00	0.45	1.000	2.27	0.45	2.00

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$. There was therefore no statistically significant difference between Group 1 and Group 2 at the beginning of the study in terms of orthopaedic tests or disability due to low back pain.

Table 4.11. Statistical results comparing Group 1 and Group 2 in terms of objective measurements from Treatment 2

	GROUP 1				GROUP 2		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	13.40	12.00	7.52	0.970	14.27	12.00	10.25
S.I. tests.	1.87	0.57	0.57	0.264	1.70	2.00	0.47

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$. There was therefore no statistically significant objective difference between Group 1 and Group 2 at the 2nd treatment.

This indicates that both groups responded equally well in terms of the results of the orthopaedic tests and the decrease in disability due to low back pain following the first treatment.

Table 4.12. Statistical results comparing Group 1 and Group 2 in terms of objective measurements from Treatment 4

	GROUP 1				GROUP 2		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	8.47	5.00	8.64	0.418	11.73	6.00	13.28
S.I. tests.	0.70	1.00	0.70	0.147	0.97	1.00	0.72

The null hypothesis was accepted for all results because $p>\alpha/2=0.025$. There was therefore no statistically significant difference between Group 1 and Group 2 at the 4th treatment.

This indicates that overall both groups responded equally well in terms of the objective improvement in the results of the orthopaedic tests, as well as the decrease in disability due to low back pain.

4.3.2.2. Intra - group analysis: Wilcoxon Signed Rank Tests

Table 4.13. Statistical results comparing Treatment 1 and Treatment 2 in terms of objective measurements from Group 1

Test	TREATMENT 1 Mean	Med.	S.D.	P - Value	TREATMENT 2 Mean	Med.	S.D.
Oswes.	18.13	19.00	8.44	**0.000**	13.40	12.00	7.52
S.I. tests.	2.27	2.00	0.45	**0.007**	1.87	2.00	0.57

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the orthopaedic tests because $p<\alpha/2=0.025$ for both results.

There was therefore a statistically significant objective improvement in Group 1 in terms of the disability due to low back pain, as well as the results of the orthopaedic tests, following the first treatment.

The statistically significant mean differences of the Oswestry Low Back Disability Index and the orthopaedic tests of Group 1 from Table 4.13 are illustrated in the form of a bar graph in Figure 4.8.

Figure 4.8. Mean Difference for Group 1 between Treatment 1 and Treatment 2

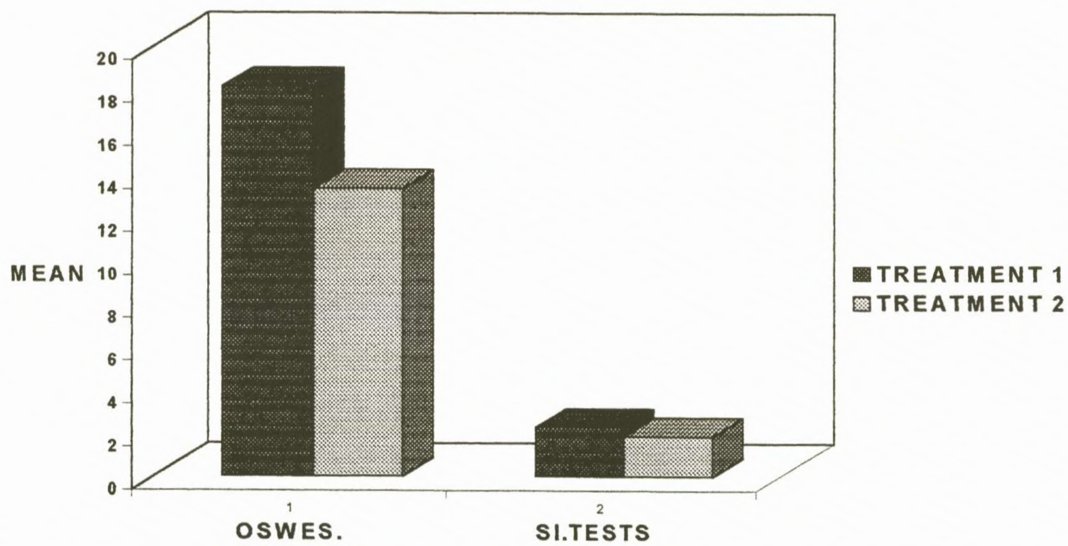


Figure 4.8. illustrates the statistically significant objective improvement in Group 1 for both the Oswestry Low Back Disability Index and orthopaedic tests between the 1st and 2nd treatment.

Table 4.14. Statistical results comparing Treatment 2 and Treatment 4 in terms of objective measurements from Group 1

	TREATMENT 2				TREATMENT 4		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	13.40	12.00	7.52	**0.000**	8.47	5.00	8.64
S.I. tests.	1.87	2.00	0.57	**0.000**	0.70	1.00	0.70

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the Orthopaedic tests because $p<\alpha/2=0.025$ for both results.

There was therefore a statistically significant objective improvement in Group 1 between the 2nd and 4th treatment with regards to the disability due to low back pain and the results of the orthopaedic tests.

The statistically significant mean differences in the Oswestry Low Back Disability Index and the orthopaedic tests of Group 1 from Table 4.14 are illustrated in the form of a bar graph in Figure 4.9.

Figure 4.9. Mean Difference for Group 1 between Treatment 2 and Treatment 4

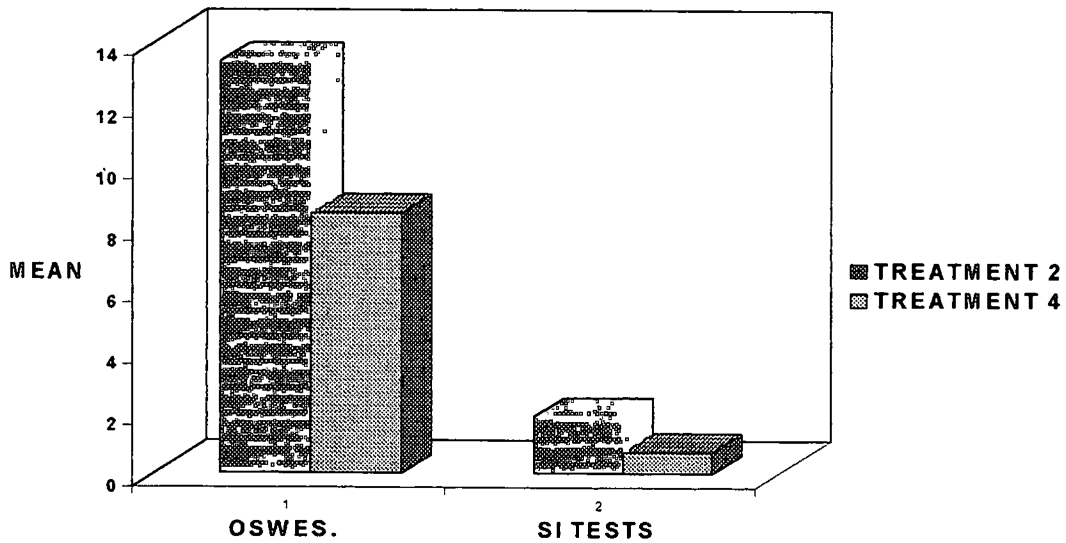


Figure 4.9. illustrates a statistically significant objective improvement in both the Oswestry Low Back Disability Index and orthopaedic tests in Group 1 between the 2nd and 4th treatment.

Table 4.15. Statistical results comparing Treatment 1 and Treatment 4 in terms of objective measurements from Group 1

	TREATMENT 1				TREATMENT 4		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	18.13	19.00	8.44	**0.000**	8.47	5.00	8.64
S.I. tests.	2.27	2.00	0.45	**0.000**	0.70	1.00	0.70

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the Orthopaedic tests because $p<\alpha/2=0.025$ for both results.

There was therefore a statistically significant objective improvement in Group 1 between the 1st and 4th treatment in terms of the disability due to low back pain and the results of the orthopaedic tests.

The statistically significant mean differences for the Oswestry Low Back Disability Index and the orthopaedic tests of Group 1 from Table 4.14 are illustrated in the form of a bar graph in Figure 4.10.

Figure 4.10. <u>Mean Difference for Group 1 between Treatment 1 and Treatment 4</u>

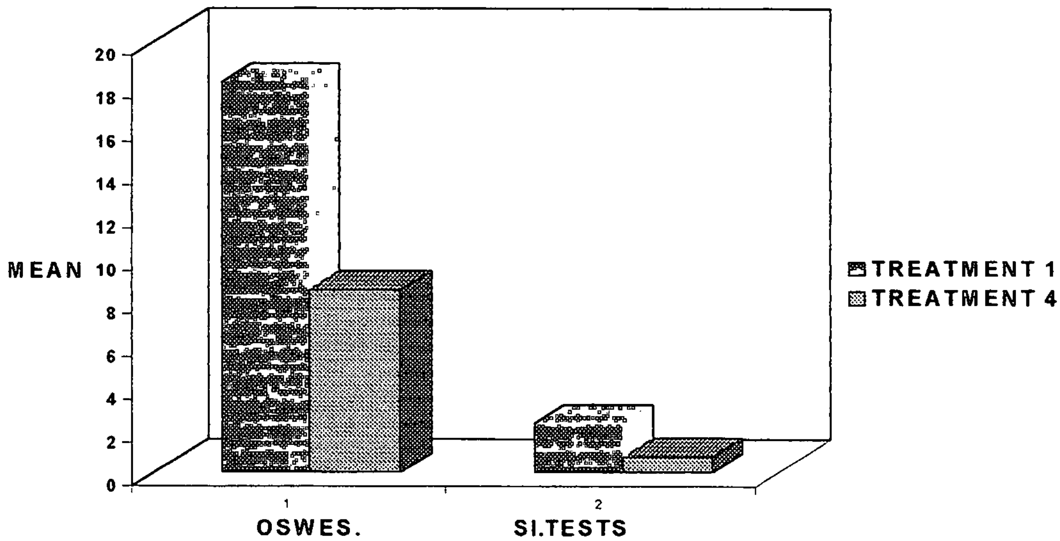


Figure 4.10. illustrates the statistically significant objective improvement in Group 1 between the 1st treatment and the 4th treatment in terms of the Oswestry Low Back Disability Index and the orthopaedic tests for the sacro - iliac joint.

It should be noted that the statistically significant improvement in disability due to low back pain, as well as the improvement in the orthopaedic tests represents the overall effect of the treatment administered to Group 1, as the results were recorded prior to the first treatment and following the final treatment.

Table 4.16. Statistical results comparing Treatment 1 and Treatment 2 in terms of objective measurements from Group 2

	TREATMENT 1				TREATMENT 2		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	20.53	19.00	10.70	**0.000**	14.27	12.00	10.25
S.I. tests.	2.27	2.00	0.45	**0.000**	1.70	2.00	0.47

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the orthopaedic tests because $p<\alpha/2=0.025$ for both results.

This indicates a statistically significant objective improvement in Group 2 between the 1st and 2nd treatment in terms of the disability due to low back pain and the results of the orthopaedic tests.

The statistically significant mean differences for the Oswestry Low Back Disability Index and the orthopaedic tests of Group 2 from Table 4.16 are illustrated in the form of a bar graph in Figure 4.11.

Figure 4.11. Mean Difference for Group 2 between Treatment 1 and Treatment 2

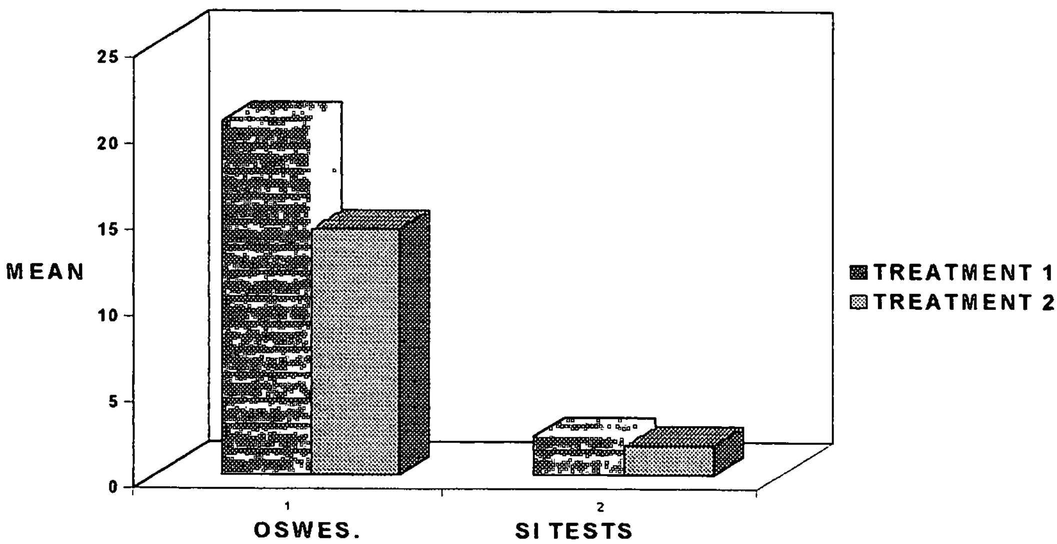


Figure 4.11. illustrates the statistically significant objective improvement of Group 2 with regards to disability due to low back pain, as well as the improvement in the results of the orthopaedic tests between the 1st and 2nd treatment.

Table 4.17. Statistical results comparing Treatment 2 and Treatment 4 in terms of objective measurements from Group 2

	TREATMENT 2				TREATMENT 4		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	14.27	12.00	10.25	**0.014**	11.73	6.00	13.28
S.I. tests.	1.70	2.00	0.47	**0.000**	0.97	1.00	0.72

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the orthopaedic tests because $p<\alpha/2=0.025$ for both results.

This indicates a statistically significant objective improvement in Group 2 between the 2nd and 4th treatment in terms of the disability due to low back pain and the results of the orthopaedic tests.

The statistically significant mean differences for the Oswestry Low Back Disability Index and the orthopaedic tests of Group 2 from Table 4.17 are illustrated in the form of a bar graph in Figure 4.12.

Figure 4.12. Mean Difference for Group 2 between Treatment 2 and Treatment 4

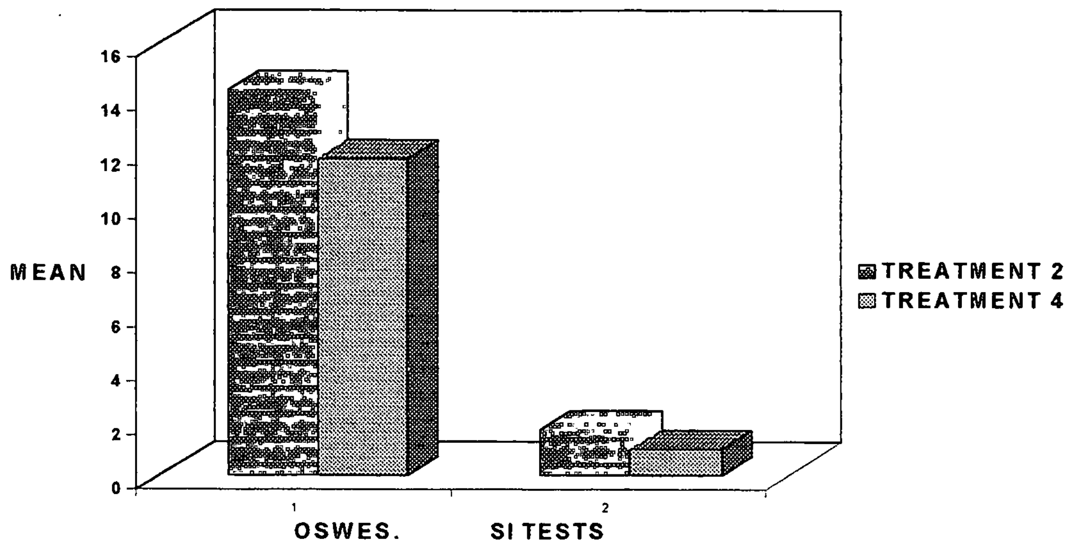


Figure 4.12. illustrates the statistically significant objective improvement of Group 2 with regards to disability due to low back pain, as well as the improvement in the results of the orthopaedic tests between the 2nd and 4th treatment.

Table 4.18. Statistical results comparing Treatment 1 and Treatment 4 in terms of objective measurements from Group 2

	TREATMENT 1				TREATMENT 4		
Test	Mean	Med.	S.D.	P - Value	Mean	Med.	S.D.
Oswes.	20.53	19.00	10.70	**0.000**	11.73	6.00	13.28
S.I. tests.	2.27	2.00	0.45	**0.000**	0.97	1.00	0.72

Note: Statistically significant P - values are highlighted in bold print.

The null hypothesis was rejected for the Oswestry Low Back Disability Index and the orthopaedic tests because $p<\alpha/2=0.025$ for both results.

There was therefore a statistically significant objective improvement in Group 2 between the 1st and 4th treatment in terms of the disability due to low back pain and the results of the orthopaedic tests.

The statistically significant mean differences for the Oswestry Low Back Disability Index and the orthopaedic tests of Group 2 from Table 4.18 are illustrated in the form of a bar graph in Figure 4.13.

Figure 4.13. Mean Difference for Group 2 between Treatment 1 and Treatment 4

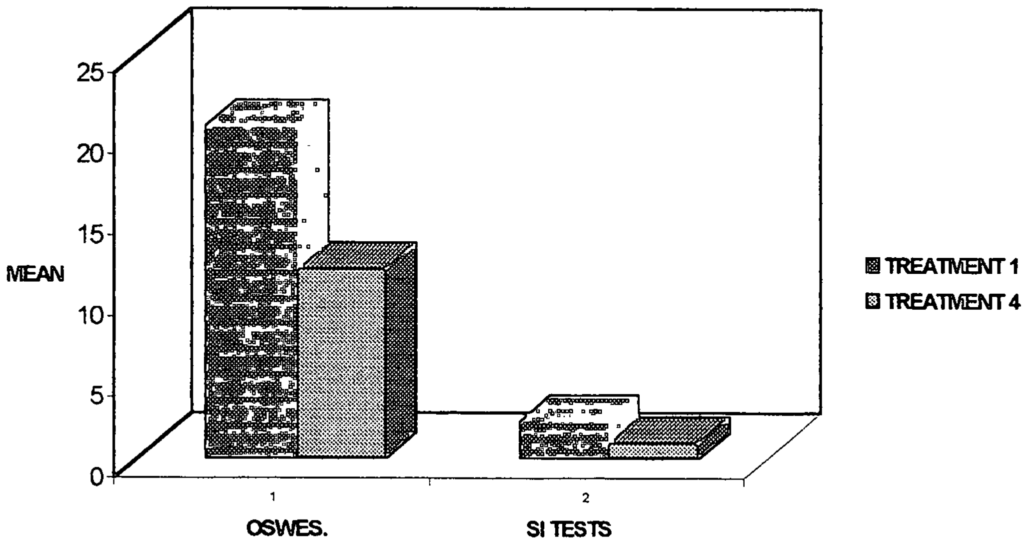


Figure 4.13. illustrates the statistically significant objective improvement in Group 2 with regards to disability due to low back pain, as well as the improvement in the results of the orthopaedic tests between the 1st and 4th treatment.

It should be noted that the statistically significant improvement in disability due to low back pain, as well as the improvement in the orthopaedic tests represents the overall effect of the treatment administered to Group 2, as the results were recorded prior to the first treatment and following the final treatment.

CHAPTER FIVE

5. DISCUSSION OF THE RESULTS

The results of the subjective and objective measurements recorded in chapter four are discussed in this chapter. The measurements obtained from the first, second, and fourth (final) treatment are discussed in two separate sections, namely:

Inter - group analysis:

The data from the first treatment from both groups was analysed in order to determine whether there was any difference between the two groups in terms of signs and symptoms of the condition as the patients presented at the commencement of treatment. A comparative analysis of the results from the second and fourth (final) treatment of both groups provided an indication as to which treatment protocol yielded a higher efficacy in terms of the treatment of sacro - iliac syndrome.

Intra - group analysis:

The data obtained from each group prior to the first and second treatment, and immediately following the fourth (final) treatment provided an indication of the efficacy of the varying number of treatments administered.

5.1. Inter - Group Analysis

5.1.1. Subjective Measurements

An inter - group analysis was conducted on the subjective measurements, namely the Numerical Pain Rating Scale 101 (Jensen et al. 1986), and the Oswestry Low Back Pain Disability Index (Fairbank et al. 1980) questionnaires.

5.1.1.1. The Numerical Pain Rating Scale

The results of the inter - group analysis of the Numerical Pain Rating Scale readings can be found in Table 4.1, Table 4.2 and Table 4.3. Statistical analysis at the first consultation revealed no significant differences in the level of pain intensity for both Group one and Group two, indicating that patients in both groups entered the study with similar levels of pain ($p=0.825$). Analysis of the data before the second consultation ($p=0.807$) and immediately following the fourth consultation ($p=0.85$) also showed no statistical difference between the groups, indicating that both treatment protocols were equally effective in reducing the intensity of pain in sacro - iliac syndrome.

5.1.1.2. The Oswestry Low Back Pain Disability Index

The results of the inter - group analysis of the Oswestry Low Back Pain Disability Index can be found in Table 4.10, Table 4.11 and Table 4.12. Statistical analysis at the first consultation revealed no significant differences in disability due to low back pain, indicating that patients in both groups entered the study with similar levels of disability due to low back pain ($p=0.481$). Analysis of the data before the second consultation ($p=0.970$) and immediately following the fourth consultation ($p=0.418$) showed no statistical difference between the groups, indicating that both treatment protocols were equally effective in decreasing the levels of disability due to low back pain.

5.1.1.3. Summary

In conclusion, it can be seen that the inter - group comparisons of the subjective data reveal that patients in both Group one and Group two entered the study with relatively similar levels of pain pressure threshold, pain intensity and disability due to their low back pain. The measurements recorded from the second and fourth consultations revealed no evidence that either Group one or Group two had benefited more from the respective treatments.

It was hypothesised that there would be a significant difference between the two groups in terms of subjective clinical findings, demonstrating one treatment protocol to be more effective for the treatment of sacro - iliac syndrome than the other. The null hypothesis was however accepted for both the subjective data collecting consultations, as neither treatment protocol showed any statistical advantage over the other. Therefore at a 95% confidence level, the two treatment protocols were equally effective in improving the symptoms of sacro - iliac syndrome.

5.1.2. Objective Measurements

An inter - group analysis was conducted on the objective measurements, namely the algometer readings taken over the sacro - iliac joints, as well as the three orthopaedic pain provocation tests for the sacro – iliac joints.

5.1.2.1. The Algometer

The results of the inter - group analysis of the algometer readings can be found in Table 4.1, Table 4.2 and Table 4.3. Statistical analysis at the first consultation revealed that patients in both groups entered the study with a similar pain threshold ($p=0.959$). Analysis of the data before the second consultation ($p=0.453$) and immediately following the fourth ($p=0.899$) consultation revealed no evidence of any statistical difference between the two groups. Both treatment protocols were therefore equally effective in increasing the pain pressure threshold.

5.1.2.2. Orthopaedic Tests

The results of the inter - group analysis of the orthopaedic tests can be found in Table 4.10, Table 4.11 and Table 4.12. Analysis of the data revealed that patients in both groups scored the same results for positive orthopaedic sacro - iliac joints tests at the onset of the treatment ($p=1.00$). There was also no statistical difference between the two groups before the second consultation ($p=0.264$) and immediately following the fourth ($p=0.147$) consultation. Both treatment protocols were therefore equally effective in reducing the number of positive orthopaedic tests, and thus reducing the signs of sacro - iliac syndrome.

5.1.2.3. Piriformis muscle flexibility

The results of the inter - group analysis of the piriformis muscle flexibility can be found in Table 4.1, Table 4.2 and Table 4.3. The comparison between the two groups revealed no statistically significant difference at the initial consultation ($p=0.66$). Both groups therefore presented with similar piriformis muscle flexibility at the commencement of treatment. There was also no statistically significant difference between the two groups before the second consultation ($p=0.62$) and immediately following the fourth consultation ($p=0.62$), indicating similar increases in piriformis muscle flexibility between the two groups in response to the treatment.

5.1.2.4. Summary

In conclusion, it can be seen that the inter - group comparisons of the objective data suggest that patients in both Group one and Group two experienced relatively similar levels of pain pressure thresholds, sacro - iliac joint orthopaedic testing, and piriformis muscle flexibility at the commencement of the study. At the second and fourth (final) consultations there was no evidence that either group had benefitted more than the other from the respective treatments.

It was hypothesised that there would be a statistically significant difference between the two groups in terms of objective clinical findings, demonstrating one treatment protocol to be more effective for the treatment of sacro - iliac syndrome than the other. The null hypothesis was however accepted for all three subjective data collecting consultations, as neither treatment protocol showed any statistical advantage over the other. Therefore at a 95% confidence level, the two treatment protocols were equally effective in improving the signs of sacro - iliac syndrome.

5.2. Intra - Group Analysis

5.2.1. Subjective Measurements

An intra - group analysis was conducted on the subjective measurements, namely the Numerical Pain Rating Scale 101 (Jensen et al. 1986), and the Oswestry Low Back Pain Disability Index (Fairbank et al. 1980) questionnaires.

5.2.1.1. The Numerical Pain Rating Scale

The results of the intra - group analysis of the Numerical Pain Rating Scale readings can be found in Table 4.4 to Table 4.9. Analysis of the comparison between the first and second consultation for both Group one (p=0.885) and Group two (p=0.785) revealed no statistically significant improvement in terms of levels of pain intensity. However, the comparison between the second and fourth consultation revealed that both Group one (p=0.000) and Group two (p=0.044) improved significantly.

Analysis of the comparison between the first consultation and the fourth consultation revealed the overall improvement in Group one (p=0.00) and Group two (p=0.001) with regards to the levels of pain intensity.

The statistically significant differences in the means between treatments for both groups was represented in the form of bar graphs in order to illustrate the symptomatic improvements following each treatment. Figure 4.4 and Figure 4.5 represent the significant mean differences between treatments for Group one. Figure 4.6 and figure 4.7 represent the significant mean differences between treatments for Group two.

5.2.1.2. The Oswestry Low Back Pain Disability Index

The results of the intra - group analysis of the Oswestry Low Back Pain Disability Index can be found in Table 4.13 to Table 4.18. Analysis of the data revealed a statistically significant improvement in terms of disability due to low back pain between the first and second consultation from both Group one ($p=0.000$) and Group two ($p=0.000$). There was also a statistically significant improvement in the disability due to low back pain between the second and fourth consultations for Group one ($p=0.000$) and Group two ($p=0.014$). The comparison between the first and fourth treatments showed the overall statistically significant improvement for Group one ($p=0.000$) and Group two ($p=0.000$).

5.2.1.3. Summary

In conclusion, it was hypothesised that there would be a significant difference between the treatments in each of the two groups in terms of subjective clinical findings. From the intra - group comparisons of the subjective data, it can be seen that patients in both Group one and Group two experienced a significant overall improvement in terms of pain threshold levels and disability due to low back pain. The null hypothesis was rejected for both subjective data collecting consultations, indicating a statistically significant improvement for both groups at a 95% confidence level.

5.2.2. Objective Measurements

An intra - group analysis was conducted on the objective measurements, namely the algometer readings taken over the sacro - iliac joints, as well as the three orthopaedic pain provocation tests for the sacro – iliac joints.

5.2.2.1. The Algometer

The intra - group analysis of the algometer readings can be found in Table 4.4 to Table 4.9. Analysis of the data revealed no statistically significant improvement between the first and second consultations for Group one (p=0.451) and Group two (p=1.000) in terms of pain pressure threshold. There was also no statistically significant improvement between the second and fourth consultations for Group one (p=1.000) and Group two (p=0.204). The comparison between the first and fourth consultations revealed the overall absence of any statistically

5.2.2.2. Orthopaedic tests

The results of the intra - group analysis of the orthopaedic tests can be found in Table 4.13 to Table 4.18. The data showed that there was a statistically significant improvement between the first and second consultations for both Group one (p=0.007) and Group two (p=0.000) in terms of a decrease in the number of positive orthopaedic tests. The comparison between the second and fourth consultations also showed a statistically significant improvement for Group one (p=0.000) and Group two (p=0.000). The comparison between the first and fourth consultations revealed the overall statistically significant objective improvement for Group one (p=0.000) and Group two (p=0.000) with regards to a decrease in the number of positive orthopaedic tests.

The statistically significant differences in the means between treatments for both groups was represented in the form of bar graphs in order to illustrate the objective improvements following each treatment. Figure 4.8, Figure 4.9 and Figure 4.10 represent the significant mean differences between treatments for Group one, while Figure 4.11, Figure 4.12 and Figure 4.13 represent the significant mean differences between treatments for Group two.

5.2.2.3. Piriformis muscle flexibility

The results of the intra - group analysis of the piriformis muscle flexibility can be found in Table 4.4 to Table 4.9. The data revealed that there was no statistically significant improvement between the first and second consultations for both Group one ($p=1.000$) and Group two ($p=1.000$) in terms of an increase in the flexibility of the piriformis muscles. The comparison between the second and fourth consultations also showed no statistically significant improvement for Group one ($p=0.629$) and Group two ($p=1.000$). The comparison between the first and fourth consultations revealed the overall absence of any statistically significant improvement for both Group one ($p=0.133$) and Group two ($p=0.337$) in terms of an objective increase in the flexibility of the piriformis muscles.

5.2.2.4. Summary

In conclusion, it was hypothesised that there would be a significant improvement between the treatments in each of the two groups in terms of objective clinical findings. The intra - group comparisons of the data suggest that patients in both Group one and Group two experienced a significant overall improvement in terms of a decrease in the number of positive orthopaedic tests. The null hypothesis was therefore rejected for the orthopaedic tests at a 95% level of confidence, indicating a statistically significant improvement for each group.

There were also objective improvements in terms of the pain pressure threshold and the piriformis muscle flexibility in both groups. The null hypothesis was, however, accepted for both these objective data collecting measurements at all consultations, as the improvement was not statistically significant for either group at a 95% confidence level.

5.3. Limitations of the Study

5.3.1. Limitations with the subjective data

A lack of stratification of patients according to baseline characteristics such as age, gender, chronicity of the problem, occupation, and extent of pain and disability, limited the homogenity of the study.

Factors such as psychological problems, stress, work habits and physical activities were not taken into consideration. These factors may have had an influence on the outcome of the study, although they were out of the researcher's control. Patients that were accepted into the study were however instructed to refrain from any sudden changes in lifestyle such as onset of vigorous exercise or activity.

The Oswestry Low Back Pain Disability Index (Fairbank et al. 1980) is a widely accepted and utilised method of subjectively evaluating low back disability. The questionnaire is however not specifically designed for evaluating sacro - iliac syndrome and this lack of specificity may have affected some of the responses, either negatively or positively.

It is also possible that some patients might not have fully understood the questionnaires, although the researcher attempted to provide clarity regarding any queries. This might have affected patient responses, either negatively or positively.

An unavoidable limitation of any study of this nature is the possibility of patients attempting to enhance their treatment response positively in order to please the researcher.

5.3.2. Limitations with the objective data

There is a possibility that the objective measurements recorded using the inclinometer and algometer contain errors due to varying reliability as a result of human error.

The experimental nature of the use of the digital inclinometer to assess the flexibility of the piriformis muscle should be noted, and while the utmost care was taken to ensure accuracy of measurement, the lack of a set test procedure allowed for the possibility of errors.

The manipulation and stretching procedures used in this study were performed by a senior chiropractic student, and not a qualified doctor of chiropractic. The lack of practical clinical experience of the researcher may thus have therefore influenced the outcome of the study.

5.4 Comparison of the Results

No study could be found in the literature that combined piriformis muscle stretching with manipulation of the sacro - iliac joint in the treatment of sacro - iliac syndrome. It was therefore not possible to make any direct comparisons to other research studies.

Salter (1999) conducted a randomised controlled clinical trial in which patients received P.N.F. stretching of the hamstring muscles in conjunction with manipulation of the sacro - iliac joints in the treatment of sacro - iliac syndrome. The C.R.A.C. technique of P.N.F. stretching (Moreau and Nook 1995) used by Salter (1999) was performed in this study, although the piriformis muscles were stretched and not the hamstrings.

It was interesting to note that Salter (1999) reported a greater short term increase in hamstring flexibility in the group that received the P.N.F. stretching of the hamstrings in conjunction with manipulation of the sacro - iliac joints. The present study however revealed that the flexibility of the piriformis muscles in both groups increased equally, although the increase was not statistically significant for either group.

Salter (1999) concluded that there were no discernable benefits to be achieved by including hamstring stretching with manipulation of the sacro - iliac joint in the treatment of sacro - iliac syndrome.

A similar conclusion to the one arrived at in the study by Salter (1999) was drawn from this study, in that no added benefit was achieved by including piriformis muscle stretching with manipulation of the sacro - iliac joint in the treatment of sacro - iliac syndrome.

<u>CHAPTER SIX</u>

6. RECOMMENDATIONS AND CONCLUSIONS

6.1 Recommendations

Patients were accepted into the study without stratification according to characteristics such as age, gender, chronicity of the problem, occupation, and extent of pain and disability. It is recommended for future studies that stratification be included in order to ensure homogenity within the two groups.

There were no blinding procedures in this study, although a single - blinded study design is recommended for future studies. Assessment of the objective measurements by someone other than the researcher would eliminate possible researcher bias and thereby increase the validity of the study.

The sample size of the study was limited to 60 patients. This allowed for the use of parametric testing which enables the detection of the subtle changes in the data. A larger sample size is however recommended, as it would minimise the possibility of a Type II error, which is incorrectly accepting the null hypothesis.

Each treatment should be scheduled as strictly as possible in order to ensure consistency and therefore validity of the treatment. For example, this study allowed for four treatments within a two week period without specification of when each treatment was to be administered. The only stipulation was that patients were not to be treated more than once a day.

Follow - up consultations are also recommended at one month, or possibly even six month intervals, in order to evaluate the intermediate and long term effects of chiropractic treatment on low back pain.

6.2 Conclusions

The results of the study indicate that both groups improved significantly in the treatment of sacro - iliac syndrome. Analysis of the subjective data showed a statistically significant improvement in the levels of pain intensity and disability due to low back pain. Analysis of the objective data revealed a statistically significant improvement in terms of the decrease of the number of positive orthopaedic tests. The objective improvement in the pain pressure threshold and the increased flexibility in the piriformis muscles was however not statistically significant. Neither group showed any statistically significant benefit over the other in terms of the two treatment protocols administered.

In conclusion, this study demonstrated that chiropractic manipulation of the sacro - iliac joint alone is as effective as chiropractic manipulation used in conjunction with the C.R.A.C. technique of P.N.F. stretching of the piriformis muscle, in the treatment of sacro - iliac syndrome.

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APPENDIX A

LETTER OF INFORMATION FOR PATIENTS ENTERING INTO THE STUDY

Dear Patient

Welcome to my research study in low back pain. I am investigating the initial effect of chiropractic treatment on low back pain. All treatment will be free of charge and will be conducted at the Technikon Chiropractic Day Clinic. Please be assured that all information will be regarded as strictly confidential.

The group to which you have been assigned has been randomly predetermined.
The following will be required:

1. X - Rays of your low back, only if indicated by the results of the initial exam.
2. Treatment for low back pain, consisting of four consultations.
3. You will be asked to complete a questionnaire at the first, second and fourth consultations.
4. No pain or anti – inflammatory medication is to be taken for the duration of the study.
5. You may not receive any other form of chiropractic treatment, physiotherapy or massage for the duration of the study.

You will remain in the study as long as you are present for each of the four appointments scheduled for you within the two – week treatment period. Please be as truthful and accurate as possible in response to all questions. There are no right or wrong answers, but your specific replies will affect the outcome of the study.

Yours sincerely

Ivan Ranwell

APPENDIX B

INFORMED CONSENT FORM

Date	: ____________
Title of research project	:THE RELATIVE EFFECTIVENESS OF MANIPULATION WITH AND WITHOUT THE CONTRACT - RELAX - ANTAGONIST - CONTRACT TECHNIQUE OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION STRETCHING OF THE PIRIFORMIS MUSCLES IN THE TREATMENT OF SACRO - ILIAC SYNDROME
Name of supervisor	: Dr. T. McDougall
Name of research student	: Ivan Ramwell

Please circle the appropriate answer		YES	NO
1.	Have you read the research information sheet?	Yes	No
2.	Have you had an opportunity to ask questions regarding this study?	Yes	No
3.	Have you received satisfactory answers to your questions?	Yes	No
4.	Have you had an opportunity to discuss this study?	Yes	No
5.	Have you received enough information about this study?	Yes	No
6.	Who have you spoken to? ______________________		
7.	Do you understand the implications of your involvement in this study?	Yes	No
8.	Do you understand that you are free to withdraw from this study? a) at any time b) without having to give any a reason for withdrawing, and c) without affecting your future health care.	Yes	No
9.	Do you agree to voluntarily participate in this study	Yes	No

If you have answered no to any of the above, please obtain the information before signing

Please Print in block letters:

Patient /Subject Name:______________________________

Signature:______________________________

Witness Name:______________________________

Signature:______________________________

Research Student Name:______________________________

Signature:______________________________

APPENDIX C

Numerical Rating Scale - 101 Questionnaire

Date:____________ File no:____________ Visit no:________

Patient name:____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience when it is at its worst. A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be".
Please write only one number.

____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience when it is at its least. A zero (0) would mean "no pain at all" and one hundred (100) would mean "pain as bad as it could be".
Please write only one number.

____

APPENDIX D
OSWESTRY BACK DISABILITY INDEX

Patient Name:______________________________ File no:______________ Date__________

This questionnaire has been designed to give the doctor information as to how your back pain has affected your ability to manage everyday life. Please answer every section and mark in each section only ONE box as it applies to you. We realize you may consider that two of the statements in any one section could relate to you, but please just mark the box which most closely describes your problem.

Section 1 - Pain Intensity

- ☐ I have no pain at the moment.
- ☐ The pain is very mild at the moment.
- ☐ The pain is moderate at the moment.
- ☐ The pain is severe at the moment.
- ☐ The pain is the worst imaginable at the moment.

Section 2 - Personal Care (Washing, Dressing ...)

- ☐ I can look after myself normally without causing extra pain.
- ☐ I can look after myself normally but it causes extra pain..
- ☐ It is painful to look after myself and I am slow and careful.
- ☐ I need some help but manage most of my personal care.
- ☐ I do not get dressed, I wash with difficulty and stay in bed.

Section 3 - Lifting

- ☐ I can lift heavy weights without extra pain.
- ☐ I can lift heavy weights but it gives extra pain.
- ☐ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example on a table.
- ☐ Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned .
- ☐ I can lift only very light weights.
- ☐ I cannot lift or carry anything at all.

Section 4 - Walking

- ☐ Pain does not prevent me walking any distance.
- ☐ Pain prevents me walking more than 1 mile (2.2km).
- ☐ Pain prevents me walking more than ½ mile (1.1km).
- ☐ Pain prevents me walking more than 1/4 mile (0.5km).
- ☐ I can only walk using a stick or crutches.
- ☐ I am in bed most of the time and have to crawl to the toilet.

Section 5 - Sitting

- ☐ I can sit in any chair as long as I like.
- ☐ I can only sit in my favorite chair as long as I like.
- ☐ Pain prevents me sitting for more than 1 hour.
- ☐ Pain prevents me from sitting for more than ½ hour.
- ☐ Pain prevents me from sitting for more than 10 minutes.
- ☐ Pain prevents me from sitting at all.

Section 6 - Standing

- ☐ I can stand as long as I want without extra pain.
- ☐ I can stand as long as I want, but it gives extra pain.
- ☐ Pain prevents me from standing for more than 1 hour.
- ☐ Pain prevents me from standing for more than ½ hour.
- ☐ Pain prevents me from standing for more than 10 minutes.
- ☐ Pain prevents me from standing at all.
- ☐

Section 7 - Sex life

- ☐ My sex life is normal and causes no extra pain.
- ☐ My sex life is normal but causes extra pain.
- ☐ My sex life is nearly normal but it is very painful.
- ☐ My sex life is severely restricted.
- ☐ My sex life is absent because of pain.
- ☐ Pain prevents any sex life at all.

Section 8 - Social life

- ☐ My social life is normal and gives no extra pain.
- ☐ My social life is normal but increases the degree of pain.
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests, for example dancing.
- ☐ Pain has restricted my social life and I do not go out as often.
- ☐ Pain has restricted my social life to my home.
- ☐ I have no social life because of pain.

Section 9 - Sleeping

- ☐ I have no trouble sleeping.
- ☐ I can sleep well only by using pills.
- ☐ Even when I take pills I have less than 6 hours sleep.
- ☐ Even when I take pills I have less than 4 hours sleep.
- ☐ Even when I take pills I have less than 2 hours sleep.
- ☐ Pain prevents me from sleeping at all.

Section 10 - Traveling

- ☐ I can travel anywhere without extra pain.
- ☐ I can travel anywhere but it gives extra pain.
- ☐ Pain is bad but I manage trips over 2 hours.
- ☐ Pain restricts me to trips less than 1 hour.
- ☐ Pain restricts me to trips under 30 minutes.
- ☐ Pain prevents me from traveling, except to the doctor and / or hospital.

Adapted from Fairbanks (1980)

APPENDIX E

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:______________________________ Date: ______________
file #:_______ X-Ray#:______________
Age:________ Sex:________ Occupation:______________
Intern:__________________ Signature:______________

FOR CLINICIAN'S USE ONLY

Initial visit clinician:__________________Signature:__________________

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

Case Status:

PTT: Conditional: Signed Off: Final Sign out:

Recommendations:

Intern's Case History

1. Source of History:

2. Chief Complaint: (patient's own words)

3. Present Illness:

- Location
- Onset
- Duration
- Frequency
- Pain (Character)
- Progression
- Aggravating Factors
- Relieving Factors
- Associated S & S
- Previous Occurrences
- Past Treatment and Outcome

4. Other Complaints:

5. Past Medical History:

- General Health Status
- Childhood Illnesses
- Adult Illnesses
- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalizations

6. Current health status and life-style:

- Allergies
- Immunizations
- Screening Tests
- Environmental Hazards (Home, School, Work)
- Safety Measures (seat belts, condoms)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

- Age
- Health
- Cause of Death
- DM
- Heart Disease
- TB
- Stroke
- Kidney Disease
- CA
- Arthritis
- Anaemia
- Headaches
- Thyroid Disease
- Epilepsy
- Mental Illness
- Alcoholism
- Drug Addiction
- Other

8. Psychosocial history:

- Home Situation and daily life
- Important experiences
- Religious Beliefs

9. Review of Systems:

- General
- Skin
- Head
- Eyes
- Ears
- Nose/Sinuses
- Mouth/Throat
- Neck
- Breasts
- Respiratory
- Cardiac
- Gastro-intestinal
- Urinary
- Genital
- Vascular
- Musculoskeletal
- Neurologic
- Haematologic
- Endocrine
- Psychiatric

TECHNIKON NATAL

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:____________________File#: ____________________Date:_________
Clinician:____________________Signature:____________________
Intern:____________________Signature:____________________

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight:

2. GENERAL EXAMINATION

General Impression:
Skin:
Jaundice:
Pallor:
Clubbing:
Cyanosis (Central/Peripheral):
Oedema:
Lymph nodes
- Head and neck:
- Axillary:
- Epitrochlear:
- Inguinal:

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease** ?

Inspection
- Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation:
- Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

Pulses:
- General Impression:
- Radio-femoral delay:
- Carotid:
- Radial:
- Dorsalis pedis:
- Posterior tibial:
- Popliteal:
- Femoral:

Percussion: - borders of heart

Auscultation:
- heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing,systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in Respiratory Distress ?

Inspection
- Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation
- Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion
- Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation
- Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:

- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V a. Sensory - Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor - Masseter:
- Jaw lateral movement:

c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:
Otoscope examination:

IX & X Gag reflex:
Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:

- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

Auscultation - Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination - Perianal skin:
- Sphincter tone & S4 Dermatome:
- Obvious masses:
- Prostate:
- Appendix:

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture - Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function - Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

G.C.S.: - Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism: - Neck mobility and Brudzinski's sign:
- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye: - Visual Acuity:
- Visual fields by confrontation:

- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
  = Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
  = Inversion & Eversion:
  = Toe (Plantarflexion & Dorsiflexion):

b. Tone
- Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes
- Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:
- Plantar:

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:

Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. SPINAL EXAMINATION:(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. BREAST EXAMINATION:

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

APPENDIX G

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
REGIONAL EXAMINATION - *LUMBAR SPINE AND PELVIS.*

PATIENT: ______________________________

FILE #: ______________ DATE: __________

INTERN/RESIDENT: ______________________

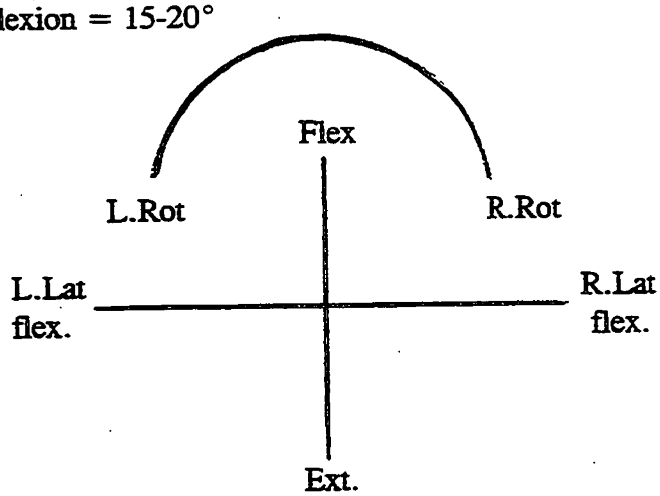
SUPERVISING CLINICIAN: ________________

STANDING:

Posture
Minor's Sign
Skin
Scars
Discoloration
Muscle Tone
Bony & Soft Tissue Contours
Spinous Percussion
Schober's Test (6cm)
Treadmill
Body Type
Attitude

RANGE OF MOTION

Forward Flexion = 40-60°(15cm from floor)
Extension = 20-35°
L/R Rotation = 3-18°
L/R Lateral Flexion = 15-20°



SUPINE:

Skin
Hair
Nails
Palpate Abdomen/groin
Pulses (abdomen)
Observe abdomen
Fasciculations
Abdominal Reflexes

Pulses (extremities)
SLR
Bowstring
Plantar Reflex
Circumference (thigh, calf)
Leg Length:
- actual
- apparent

Sciatic Notch
Patrick FABERE
Gaenslen's Test
Gluteus Maximus Stretch
Hip Medial rotation
Psoas Test
Thomas' Test:
- hip joint
- Rectus Femoris

<u>LATERAL RECUMBENT</u>

S-I Compression
Ober's Test
Femoral Nerve stretch
Myotomes:
- QL
- Gluteus Medius

<u>NON ORGANIC SIGNS</u>

Pin Point Pain
Axial Compression
Trunk Rotation
Burn's Bench Test
Flip Test
Hoover's Test
Ankle Dorsiflexion Test.

<u>GAIT</u>

Rhythm
On toes (standing)
On Heels (standing)
Half squat on one leg

<u>PRONE</u>

Gluteal skyline
Skin rolling
Iliac crest compression
Facet joint challenge
S-I tenderness
Erichson's Test
Pheasant's Test
Myotome:
- Glut. Max

Active MF Trigger Pts:
- QL
- Glut. Med
- Glut. Min
- Glut. Max
- Piriformis
- Hamstrings
- TFL

NEUROLOGICAL EXAMINATION

DERMATOMES			MYOTOMES			REFLEXES		
	L	R		L	R		L	R
T12			Hip Flex			Pat.		
L1			Hip int rot			Achil		
L2			Hip ext rot			H/S		
L3			Hip abd					
L4			Hip add					
L5			Knee flex					
S1			Knee ext					
S2			Dorsiflex					
S3			Plantarflex					
			Eversion					
			Ext.hal.long					

Tripod
Kemp's Test

MOTION PALPATION and JOINT PLAY:

LEFT: Upper Thoracics:
Lumbar Spine:
Sacroiliac Joint:

RIGHT: Upper Thoracics:
Lumbar Spine:
Sacroiliac Joint:

Basic Exam: Hip
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic/Neuro/
Vascular:

Observ/Palpation:

Basic Exam: Thoracic Spine
Case History:

ROM: Motion Palp:
Active:
Passive:
Orthpaedic/Neuro/
Vascular:

Observ/Palpation: